United States Department of Agriculture

Soil Conservation Service

In cooperation with Michigan Department of Agriculture, Michigan Agricultural Experiment Station, and Michigan Technological University

Soil Survey of Cass County, Michigan

How To Use This Soil Survey

General Soil Map

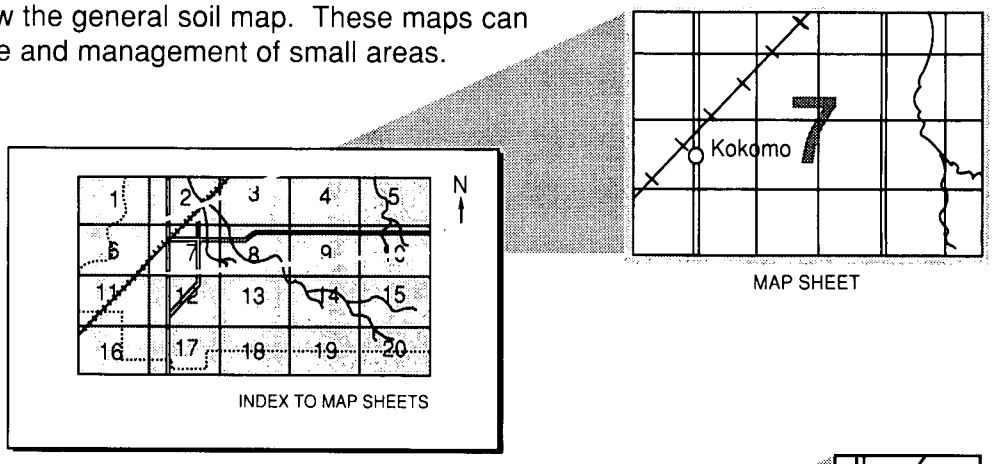
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

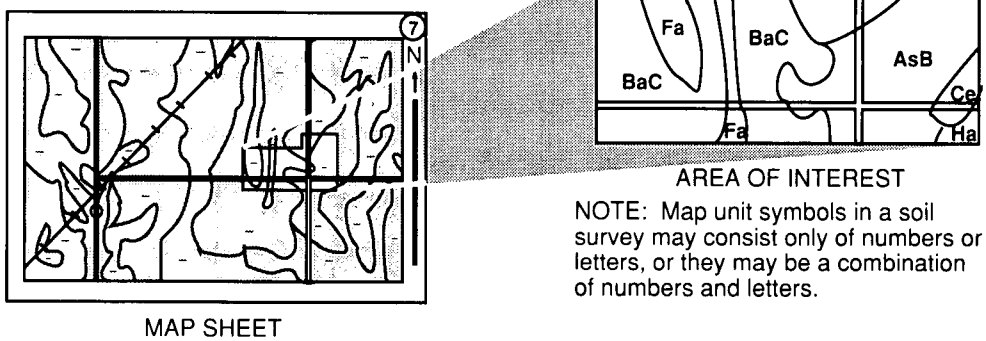
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

MAP SHEET

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1987. Soil names and descriptions were approved in 1988. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1987. This survey was made cooperatively by the Soil Conservation Service, the Michigan Department of Agriculture, the Michigan Agricultural Experiment Station, and Michigan Technological University. It is part of the technical assistance furnished to the Cass County Soil Conservation District. Financial assistance was made available by the Cass County Board of Commissioners.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: A well managed hog-farrowing area in the Spinks-Oshtemo-Ormas association. Cass County ranks first in the state in hog production.

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Issued July 1991

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Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Cass County, Michigan. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Homer R. Hilner
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Soil Survey of Cass County, Michigan

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United States Department of Agriculture, Soil Conservation Service,
in cooperation with Michigan Department of Agriculture, Michigan Agricultural Experiment Station, and Michigan Technological University

CASS COUNTY is in the southwestern part of the Lower Peninsula of Michigan (fig. 1). The county is bordered on the north by Van Buren County, Michigan; on the west by Berrien County, Michigan; on the southwest by St. Joseph County, Indiana; on the southeast by Elkhart County, Indiana; and on the east by St. Joseph County, Michigan. The total area of the county is 317,581 acres, or about 496 square miles. Cassopolis is the county seat. The population of the county was 49,499 in 1980.

About 70 percent of the county is used for agricultural purposes, 20.5 percent is forested, 4.7 percent is in urban areas more than 10 acres in size, and 4.8 percent is areas of roads, bodies of water, or urban areas less than 10 acres in size *(14)*. Farming is the main economic enterprise in the county.

This survey updates the soil survey of Cass County published in 1906 *(4)*. It provides additional information and larger maps, which show the soils in greater detail.

Figure 1.—Location of Cass County in Michigan.

General Nature of the County

This section gives general information about the county. It describes climate, history and development, physiography, lakes and streams, and native vegetation.

Climate

Prepared by the Michigan Department of Agriculture, Climatology Division, East Lansing, Michigan.

Table 1 gives data on temperature and precipitation for the county as recorded at Dowagiac, Eau Claire, and Three Rivers, Michigan, in the period 1951 to 1980. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring at Eau Claire and Three Rivers. Table 3 provides data on length of the growing

season at Eau Claire and Three Rivers.

In winter the average temperature is 25.9 degrees F at Dowagiac, 26.3 degrees at Eau Claire, and 25.8 degrees at Three Rivers. The lowest temperature on record is -23 degrees at Dowagiac, -21 degrees at Eau Claire, and -22 degrees at Three Rivers. In summer, the average temperature is 70 degrees at Dowagiac, 70.8 degrees at Eau Claire, and 70.2 degrees at Three Rivers and the average daily maximum temperature is 82.5 degrees at Dowagiac, 81.5 degrees at Eau Claire, and 82.4 degrees at Three Rivers. The highest recorded temperature is 103 degrees at Dowagiac and 107 degrees at Eau Claire and Three Rivers.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The average seasonal snowfall is 74.0 inches at Dowagiac, 69.8 inches at Eau Claire, and 45.9 inches at Three Rivers. The greatest snow depth at any one time during the period of record was 37 inches at Dowagiac, 31 inches at Eau Claire, and 27 inches at Three Rivers. On the average, 61 days of the year at Dowagiac and Eau Claire and 64 days at Three Rivers have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The highest recorded seasonal snowfall was 117.3 inches during the winter of 1958-59 at Dowagiac, 135.5 inches during the winter of 1977-78 at Eau Claire, and 65.4 inches during the winter of 1977-78 at Three Rivers. The lowest recorded seasonal snowfall was 18.5 inches during the winter of 1948-49 at Dowagiac, 10.5 inches during the winter of 1936-37 at Eau Claire, and 13.5 inches during the winter of 1948-49 at Three Rivers. The highest recorded monthly snowfall was 55.0 inches in January 1959 at Dowagaic, 68.0 inches in January 1978 at Eau Claire, and 31.4 inches in December 1951 at Three Rivers. The heaviest recorded 1-day snowfall was 13.3 inches at Dowagiac, 15.0 inches at Eau Claire, and 18.0 inches at Three Rivers.

The total annual precipitation is 21.66 inches at Dowagiac, 35.12 inches at Eau Claire, and 33.56 inches at Three Rivers. Of these totals, 21.66 inches at Dowagiac, 20.13 inches at Eau Claire, and 20.39 inches at Three Rivers usually fall in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 18.1 inches at Dowagiac, less than 16.9 inches at Eau Claire, and less than 17.4 inches at Three Rivers. The heaviest 1-day rainfall during the period of record was 4.9 inches at Dowagiac on July 23, 1959; 5.07 inches at Eau Claire on August 17, 1935; and 3.94 inches at Three Rivers on July 21, 1976. Thunderstorms occur on about 42 days each year at Dowagiac and Eau Claire and on about 36 days each year at Three Rivers.

The average relative humidity in midafternoon is about 63 percent. Humidity is higher at night, and the average at dawn is about 82 percent. The sun shines 62 percent of the time possible in summer and 31 percent in winter. The prevailing wind is from the south-southwest.

History and Development

On November 5, 1829, the Territorial Legislature of Michigan established Cass County, which was named in honor of Governor Lewis Cass. The first settler, Uzziel Putnam, arrived November 18, 1825. He established the first settlement in southwest Michigan. The first school west of Detroit was opened in Pokagon Township in 1828.

Interest in the survey area was first generated in 1821, when French and Indian traders returning east told of the abundant natural resources in the area. The small areas of fertile prairie were available for farming, and the vast forests offered an abundance of game and the materials needed for settlement.

When the first settlers arrived, three bands of Potawatomi Indians already occupied the survey area. The Weesaw Band numbered about 150, the Shavehead Band about 75, and the Pokagon Band about 250. These Indians engaged in rudimentary farming, maintaining garden plots in every prairie in the survey area. By 1833, the Indians had to forfeit all their land and were forced to move to Kansas as part of the tragic march known as the "Trail of Tears." The Pokagon Band was able to resist this forced march and legally purchased 1,000 acres in Silver Creek Township.

Black history is also an important chapter in Cass County. In 1836, Henry Way, a Quaker preacher, assisted in the escape of the first fugitive slave, marking the beginning of the Underground Railroad in Cass County. By 1848, two main lines of the railroad formed a junction in the county—the "Quaker Line," which ran north from Kentucky, and the "Illinois Line," which ran from near St. Louis. More than 1,500 slaves passed through the county on their way to Canada during this period. The infamous "Kentucky Raid" of 1847 was aimed partly at Calvin Township. The raids into Michigan were led by 13 Kentucky landowners, who were attempting to recover escaped slaves. Although they failed in these attempts, the incidents led to the

passage of the Fugitive Slave Act in 1850. This act increased the hostility between the North and the South in the years preceding the Civil War *(3)*.

Industry during the settlement period was limited to grist and flour mills until the advent of the railroad in 1848. The railroad attracted several industries, including a lumber mill, a foundry, and a farm implement manufacturer. The roller grain drill and spring tooth harrow were invented in Cass County. The foundry later became the world-famous "Round Oak Furnace Company." The stove works and implement companies no longer operate, but the county still has a viable economic base. The chief industrial enterprises manufacture recreational vehicles, fishing tackle, and doors. Various small shops supply the auto industry.

Natural resources play a major role in the economy of the county. Farming is the leading industry. The county ranks first in the state in hog production. About 250,000 hogs are raised in the county annually. An important tourist industry has developed around the many lakes in the county. Lumber production also is an important part of the economy of the county. Especially important are high-quality black walnut and red oak used for furniture and lower grades used for pallets.

Physiography

The physiography of Cass County is the result of the Cary substage of the Wisconsin Glaciation. The three main lobes of this substage were the Erie, the Saginaw, and the Lake Michigan. As the Saginaw lobe retreated, the Lake Michigan lobe advanced, overriding the deposits of the Saginaw lobe. The glacial landscape left behind by the retreat of the Lake Michigan lobe consisted of outwash plains, glacial drainageways, recessional end moraines, ground moraines, and small glacial lakes.

The county has three major outwash plains. These extend from the southwestern part of the county to the northwestern part. The largest one covers most of the southern townships from Porter to Ontwa and extends from Ontwa in a narrow band through the central part of Marcellus Township. Another relatively narrow band extends from the western part of Milton Township through Volinia and the western part of Marcellus Township. The third plain covers the northwestern part of Pokagon Township and extends through the central part of Silver Creek Township. The three plains at one time served as glacial drainageways. An area encompassing the north branch of the Dowagiac Creek still serves as a drainageway.

The county has three recessional end moraines. These are the Sturgis, Kalamazoo, and Valparaiso moraines. The Sturgis moraine is mainly in Newberg, Porter, and Calvin Townships and in the eastern part of Penn Township. The inner and outer ridge of the Kalamazoo moraine generally runs diagonally across the county from Milton Township through the northwestern and southeastern parts of Volinia Township. The Valparaiso moraine runs primarily through the northwestern part of Silver Creek Township.

The most extensive ground moraine in the county is part of the Sturgis moraine in Porter Township. Another moraine occurs as a narrow band extending from southwest Wayne Township to its northeast border.

Small glacial lakes were created by the action of the ice. What is believed to be a remnant of one such lake is located in Pokagon Township. It is about 1 mile wide and extends from the south-central border to the northeast corner of the township. Another remnant is near the northwest border of Wayne Township. It protrudes about 1 mile into the county from Van Buren County.

Lakes and Streams

Numerous kettle holes, swamps, and lakes are throughout Cass County (fig. 2). Some of the lakes are connected by streams through bordering swamps.

The county has 15 watersheds, all of which are part of the St. Joseph River basin. This basin is part of the larger Lake Michigan drainage basin. The chief watercourses on these watersheds are Dowagiac Creek, Christiana Creek, and the St. Joseph River. The waterway and stream patterns in the county are immature. The county generally has no definite drainage pattern (fig. 3). Floods and long periods of high water are not serious problems in the county.

Native Vegetation

At one time most of Cass County was covered by forest vegetation. During the period from 2000 B.C. to A.D. 1800, the dominant species in the survey area were oak and pine. From 1800 to the present, the two most extensive plant associations in the county were the oak-hickory and beach-maple associations *(5)*. About 59 percent of the county was oak-hickory, and 28 percent was beech-maple. Lake and swamp vegetation made up about 9 percent and dry prairie the remaining 4 percent.

Openings in the forest were covered by tall grasses and numerous flowering plants. These areas could be more easily prepared for cultivation than other areas in the county and were the first to be used for farming. Forests were cleared and the ground broken. Very few of the areas of muck on lowlands were cleared and used for agriculture. Most of the present woodland

Figure 2.—Residential development around one of the many lakes in Cass County.

consists of small woodlots, broad areas of hilly soils, and low, wet areas.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; and the kinds of crops and native plants growing on the soils. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the county occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the county and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between

the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the county and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the county, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot

Figure 3.—Typical drainage pattern in an area of the Houghton association.

experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the county, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this county. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions, names, and delineations of the soils on the general soil map of this county do not fully match or agree with those of the soils on older maps of adjacent counties. Differences are the result of a better knowledge of soils, modifications in series concepts, and variations in the intensity of mapping or in the extent of the soils in the counties.

Soil Descriptions

1. Kalamazoo-Oshtemo Association

Nearly level to hilly, well drained, loamy soils; on outwash plains and moraines

This association consists of soils on broad flats and hills on outwash plains and moraines. Slopes range from 0 to 18 percent.

This association makes up about 49 percent of the county. It is about 60 percent Kalamazoo and similar soils, 30 percent Oshtemo and similar soils, and 10 percent minor soils.

Typically, the surface layer of the Kalamazoo soils is dark grayish brown loam about 9 inches thick. The subsoil is about 33 inches thick. In sequence downward, it is dark brown, firm clay loam; strong brown, friable sandy clay loam; dark brown, friable gravelly sandy clay loam; dark brown, very friable sandy loam; and dark brown, very friable loamy sand. The substratum to a depth of about 60 inches is dark brown gravelly sand and dark yellowish brown sand.

Typically, the surface layer of the Oshtemo soils is dark brown sandy loam about 11 inches thick. The subsoil is about 31 inches thick. The upper part is brown and dark brown, friable sandy loam. The lower part is strong brown, very friable loamy sand that has bands of dark brown sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand that has bands of dark brown sandy loam.

Minor in this association are the well drained Spinks and somewhat excessively drained Coloma soils. These soils are coarser textured throughout than the major soils. Also, they are slightly lower on the landscape.

Most areas of this association are used as cropland. The major soils are well suited, fairly well suited, or poorly suited to cropland and are well suited or fairly well suited to pasture. Droughtiness, water erosion, soil blowing, and the content of organic matter are concerns in managing cropland. Plant competition is the major limitation in wooded areas.

The major soils are well suited, fairly well suited, or poorly suited to building site development and sanitary facilities. The slope of the gently rolling to hilly soils is a limitation.

2. Spinks-Oshtemo-Ormas Association

Nearly level to steep, well drained, sandy and loamy soils; on outwash plains and moraines

This association consists of soils on broad flats and hillsides on outwash plains and moraines. Slopes range from 0 to 35 percent.

This association makes up about 25 percent of the county. It is about 60 percent Spinks and similar soils, 20 percent Oshtemo and similar soils, 10 percent Ormas and similar soils, and 10 percent minor soils.

Spinks soils are nearly level to steep. Typically, the surface layer is dark brown loamy sand about 10 inches thick. The subsurface layer is yellowish brown, very friable loamy fine sand about 8 inches thick. The next 35 inches is yellowish brown and dark yellowish brown,

very friable loamy sand that has bands of dark brown sandy loam. The substratum to a depth of about 60 inches is brown sand.

Oshtemo soils are nearly level to steep. Typically, the surface layer is dark brown sandy loam about 11 inches thick. The subsoil is about 31 inches thick. The upper part is brown and dark brown, friable sandy loam. The lower part is strong brown, very friable loamy sand that has bands of dark brown sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand that has bands of dark brown sandy loam.

Ormas soils are nearly level to gently rolling. Typically, the surface layer is dark brown loamy sand about 9 inches thick. The subsoil is about 37 inches thick. The upper part is yellowish brown, very friable loamy sand. The lower part is dark yellowish brown, friable sandy loam and yellowish brown, friable gravelly sandy loam. The substratum to a depth of about 60 inches is yellowish brown gravelly loamy sand.

Minor in this association are the somewhat excessively drained Coloma and well drained Kalamazoo soils. These soils are in positions on the landscape similar to those of the major soils. Kalamazoo soils have a subsoil that is finer textured than that of the major soils.

Most areas of this association are used as cropland. The nearly level and undulating soils generally are used as cropland. The gently rolling to steep soils are used mainly as woodland.

The nearly level and undulating soils are well suited or fairly well suited to cropland and pasture. The gently rolling to steep soils generally are poorly suited or unsuited to those uses. Water erosion, soil blowing, droughtiness, and the organic matter content are the major concerns in managing cropland. Seedling mortality, plant competition, the erosion hazard, and the equipment limitation are the major concerns in managing woodland.

The major soils are well suited, fairly well suited, poorly suited, or generally unsuited to building site development and sanitary facilities. The nearly level and undulating soils are well suited to those uses. The slope of the gently rolling to steep soils and a poor filtering capacity in the sandier soils are limitations.

3. Schoolcraft-Elston Association

Nearly level and undulating, well drained, loamy soils; on outwash plains

This association consists of soils on broad flats and slight knolls on outwash plains. Slopes range from 0 to 6 percent.

This association makes up about 5 percent of the county. It is about 85 percent Schoolcraft and similar soils, 10 percent Elston and similar soils, and 5 percent minor soils.

Typically, the surface layer of the Schoolcraft soils is very dark grayish brown loam about 11 inches thick. The subsoil is about 22 inches thick. It is dark yellowish brown. The upper part is firm clay loam and sandy clay loam, and the lower part is friable sandy loam. The substratum to a depth of about 63 inches is yellowish brown sand that has bands of dark yellowish brown loamy sand.

Typically, the surface layer of the Elston soils is black sandy loam about 14 inches thick. The subsoil is about 27 inches thick. The upper part is dark yellowish brown, friable sandy clay loam. The next part is dark yellowish brown, very friable sandy loam. The lower part is dark brown, very friable loamy sand. The substratum to a depth of about 60 inches is strong brown and yellowish brown sand.

Minor in this association are the well drained Kalamazoo and Oshtemo soils. These soils have a surface layer that is thinner and lighter colored than that of the major soils. They are in positions on the landscape similar to those of the major soils.

Most areas in this association are cropped. The major soils are well suited to cropland. Water erosion, soil blowing, and droughtiness are concerns in managing cropland.

The major soils are well suited or fairly well suited to building site development and sanitary facilities. A poor filtering capacity is a limitation on sites for sanitary facilities.

4. Cassopolis-Riddles-Teasdale Association

Nearly level to steep, well drained to somewhat poorly drained, loamy soils; on till plains and moraines

This association consists of soils on broad flats, knolls, and hills on till plains and moraines. Slopes range from 0 to 35 percent.

This association makes up about 12 percent of the county. It is about 42 percent Cassopolis and similar soils, 28 percent Riddles and similar soils, 22 percent Teasdale and similar soils, and 8 percent minor soils.

Cassopolis soils are on broad flats and are moderately well drained. They are undulating. Typically, the surface layer is very dark grayish brown fine sandy loam about 8 inches thick. The next 3 inches is brown and dark brown, friable fine sandy loam and loam. The subsoil extends to a depth of about 65 inches. It is dark yellowish brown and firm. The upper part is clay loam, the next part is mottled sandy clay loam, and the lower part is mottled loam.

Riddles soils are on knolls and hills and are well drained. They are gently rolling to steep. Typically, the

surface layer is dark brown fine sandy loam about 7 inches thick. The upper part of the subsoil is brown, firm clay loam and loam. The lower part to a depth of about 60 inches is brown and yellowish brown, friable sandy loam.

Teasdale soils are in slight depressions on broad flats and are somewhat poorly drained. They are nearly level. Typically, the surface layer is dark brown fine sandy loam about 9 inches thick. The subsurface layer is brown, friable fine sandy loam about 8 inches thick. The next 14 inches is dark yellowish brown loam and brown fine sandy loam. The subsoil is yellowish brown, mottled loam about 17 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled fine sandy loam.

Minor in this association are the poorly drained Barry and well drained Kalamazoo soils. Barry soils are in drainageways and in the lower areas. Kalamazoo soils are sandy in the lower part of the subsoil. They are in landscape positions similar to those of the Riddles soils.

The nearly level to gently rolling soils in this association are used mainly as cropland. The hilly or steep soils are used as woodland. The major soils are well suited or fairly well suited to cropland and pasture. The main concerns in managing cropland are the wetness of the somewhat poorly drained Teasdale soils and the hazard of water erosion on the well drained Riddles and moderately well drained Cassopolis soils. Plant competition, the erosion hazard, and the equipment limitation are the main concerns in managing woodland.

The major soils are well suited, fairly well suited, poorly suited, or generally unsuited to building site development and sanitary facilities. The nearly level and undulating, well drained and moderately well drained soils are fairly well suited to those uses. The slope of the rolling to steep soils and the wetness of the somewhat poorly drained soils are limitations.

5. Glendora-Adrian-Cohoctah Association

Nearly level, very poorly drained, mucky and loamy soils; on flood plains and in old glacial lakebeds

This association consists of soils on flood plains and in depressions and drainageways in glacial lakebeds. Slopes range from 0 to 2 percent.

This association makes up about 6 percent of the county. It is about 43 percent Glendora and similar soils, 34 percent Adrian and similar soils, 15 percent Cohoctah and similar soils, and 8 percent minor soils.

Typically, the surface layer of the Glendora soils is black muck about 6 inches thick. The next layer is black mucky fine sandy loam about 3 inches thick. The upper part of the substratum is light brownish gray loamy fine sand. The lower part to a depth of about 60 inches is grayish brown sand.

Typically, the upper 9 inches of the Adrian soils is black muck. Below this is black, friable muck about 11 inches thick. The substratum to a depth of about 60 inches is light olive brown fine sand and brown sand.

Typically, the surface layer of the Cohoctah soils is black loam about 11 inches thick. The substratum extends to a depth of about 60 inches. It is mottled. In sequence downward, it is dark gray fine sandy loam, light brownish gray fine sandy loam, pale brown sand, and grayish brown and light brownish gray fine sand.

Minor in this association are the very poorly drained Palms and Gilford soils. Palms soils are in positions on the landscape similar to those of the major soils. They are mucky soils underlain by loamy material. Gilford soils are similar to the Cohoctah soils. They are along the edges of the areas of the association.

Most areas of this association are used as woodland. Some are used as cropland. The major soils are generally unsuited or poorly suited to cropland and pasture. Flooding, wetness, and soil blowing are the major concerns in managing cropland. The equipment limitation, plant competition, seedling mortality, and the windthrow hazard are the major concerns in managing woodland.

The major soils are generally unsuited to building site development and sanitary facilities. The major management concerns are flooding and wetness.

6. Houghton Association

Nearly level, very poorly drained, mucky soils; in old glacial lakebeds

This association consists of soils in depressions and drainageways in old glacial lakebeds. Slopes range from 0 to 2 percent.

This association makes up about 3 percent of the county. It is about 95 percent Houghton and similar soils and 5 percent minor soils.

Typically, the surface tier of the Houghton soils is black muck about 15 inches thick. Below this to a depth of about 60 inches is dark reddish brown, friable muck.

Minor in this association are the very poorly drained Adrian, Palms, and Gilford soils. Adrian and Palms soils are in positions on the landscape similar to those of the Houghton soils. They have mineral material within a depth of 50 inches. Gilford soils formed in loamy and sandy deposits. They are along the edges of the areas of the association.

Most areas of this association are used as woodland. Some are cropped. If drained, the Houghton soils are fairly well suited to cropland. Ponding, wetness, and soil blowing are the major concerns in managing cropland.

The windthrow hazard, plant competition, the equipment limitation, and seedling mortality are the major concerns in managing woodland.

The Houghton soils are generally unsuited to building site development and sanitary facilities. The major management concerns are ponding and wetness.

Broad Land Use Considerations

The general soil map is helpful in identifying broad areas that can be developed for residential, industrial, agricultural, and other uses. It cannot be used, however, in the selection of sites for specific structures or specific crops. The paragraphs that follow describe the major land uses in the county.

Cropland

About 51 percent of the county is used for cultivated crops. The main crops are soybeans and corn *(14)*. Most of the cropland is in associations 1, 2, 3, and 4.

The very poorly drained soils in associations 5 and 6 generally are not cultivated because of excess water, a scarcity of adequate drainage outlets, flooding or ponding, and the hazards of soil blowing and subsidence in areas of muck after a drainage system is installed. If future economic conditions are favorable, it may be feasible to clear and drain these soils and use them for vegetables or other specialty crops.

Generally, the well drained and moderately well drained, nearly level or undulating soils in associations 1, 2, 3, and 4 are well suited or fairly well suited to cropland. Erosion-control measures may be needed on the steeper slopes. The soils in associations 1, 2, and 3 tend to become droughty during dry periods. The more sloping areas of these associations are better suited to woodland, pasture, or permanent hayland.

Woodland

About 20.5 percent of the county is wooded *(14)*. The soils in most of the associations are productive woodland sites. The major soils in associations 5 and 6, however, are generally not productive as woodland. These very poorly drained soils support mixed stands of maple, aspen, and oak. Most of the upland soils in associations 2, 3, and 4 support hardwoods.

Because of wetness, the slope, or a sandy surface layer, the equipment limitation is the main concern in managing the woodland in Cass County. Plant competition, seedling mortality, and windthrow also are management concerns on some soils.

Urban Development

About 5 percent of Cass County is urban or built-up land *(14)*. The poorly drained and very poorly drained soils are generally unsuited to urban development because of ponding or wetness. The soils in the upland areas of associations 1, 2, 3, and 4 generally are suited to urban development. The sandy soils in associations 1, 2, and 3, however, have a poor filtering capacity if they are used as sites for septic tank absorption fields.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Kalamazoo loam, 0 to 2 percent slopes, is a phase of the Kalamazoo series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Spinks-Oshtemo complex, 2 to 6 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Histosols and Aquents, ponded, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Some of the boundaries on the detailed soil maps of Cass County do not match those on the soil maps of adjacent counties, and some of the soil names and descriptions do not fully agree. Differences are the result of modifications or refinements in soil series concepts and variations in the intensity of mapping or in the extent of the soils in the counties.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

2—Histosols and Aquents, ponded. These nearly level, very poorly drained soils are along river tributaries, on the margins of lakes, and in depressions. They are ponded throughout most of the year. Individual areas are long and narrow or irregularly shaped and range from 3 to more than 600 acres in size. They typically are about 60 to 70 percent Histosols and 30 to 40 percent Aquents.

Typically, the upper part of the Histosols is black

Figure 4.—An area of Histosols and Aquents, ponded, which provide an ideal habitat for wetland wildlife.

muck 16 to 51 inches thick. The substratum to a depth of about 60 inches is gray sandy loam and loam.

Typically, the Aquents have a black, loamy surface layer about 10 inches thick. The substratum to a depth of about 60 inches is gray loam. In places the soils have a sandy subsoil.

Most areas support cattails, reeds, and water-tolerant grasses and shrubs (fig. 4). Clumps of trees are common in most areas. Many of the trees are dead. These soils have good potential for wetland wildlife habitat. They are generally unsuited to cultivated crops, pasture and hay, woodland, and most engineering uses.

These soils are not assigned to interpretive groups.

3A—Schoolcraft loam, 0 to 2 percent slopes. This nearly level, well drained soil is in broad areas on uplands. Individual areas are irregularly shaped and range from 5 to 340 acres in size.

Typically, the surface layer is very dark grayish brown loam about 11 inches thick. The subsoil is about 22 inches thick. It is dark yellowish brown. The upper part is firm clay loam and sandy clay loam, and the lower part is friable sandy loam. The substratum to a depth of about 63 inches is yellowish brown sand that has dark yellowish brown bands of loamy sand. In some places the surface layer is less than 10 inches thick. In other places the subsoil has slightly less clay. In some areas the surface layer is silt loam.

Included with this soil in mapping are small areas of soils that have a slope of 2 to 4 percent. These soils make up about 7 percent of the unit.

Permeability is moderate in the upper part of the Schoolcraft soil and rapid in the lower part. The available water capacity is moderate. Surface runoff is slow.

This soil is used mainly as cropland. It is well suited to such crops as corn, soybeans, and winter wheat. The major management concern is droughtiness. A system

of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface conserves moisture. If the soil moisture level is low, irrigation can increase crop yields. If the soil is irrigated, water application rates should be regulated and equipment lanes should be seeded because of the hazard of erosion.

This soil is well suited to pasture. The main concern in managing pastured areas is conserving moisture during dry periods, when the amount of soil moisture is insufficient for optimum plant growth. Rotation grazing or strip grazing and restricted use during dry periods help to maintain forage production.

This soil is well suited to building site development. It is suited to septic tank absorption fields, but it has a poor filtering capacity. It readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in pollution of the ground water.

The land capability classification is IIs, and the Michigan soil management group is 2.5a. No woodland ordination symbol is assigned.

3B—Schoolcraft loam, 2 to 4 percent slopes. This undulating, well drained soil is on low knolls and in broad areas on uplands. Individual areas are irregularly shaped and range from 3 to 250 acres in size.

Typically, the surface layer is very dark grayish brown loam about 11 inches thick. The subsoil is about 22 inches thick. It is dark yellowish brown. The upper part is firm clay loam and sandy clay loam, and the lower part is friable sandy loam. The substratum to a depth of about 63 inches is yellowish brown sand that has dark yellowish brown bands of loamy sand. In some places the surface layer is less than 10 inches thick. In other places it is lighter in color. In some areas the subsoil has slightly less clay. In other areas the surface layer is silt loam.

Permeability is moderate in the upper part of the profile and rapid in the lower part. The available water capacity is moderate. Surface runoff is slow.

This soil is used mainly as cropland. It is well suited to such crops as corn, soybeans, and winter wheat. The main management needs are measures that help to control water erosion and maintain the supply of soil moisture. Examples are stripcropping, cover crops, and a system of conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface. If the soil moisture level is low, irrigation can increase crop yields. If the soil is irrigated, water application rates should be regulated and equipment lanes should be seeded because of the hazard of erosion.

This soil is well suited to pasture. The main concern in managing pastured areas is conserving moisture during dry periods, when the amount of soil moisture is insufficient for optimum plant growth. Rotation grazing or strip grazing and restricted use during dry periods help to maintain forage production.

This soil is well suited to building site development. It is suited to septic tank absorption fields, but it has a poor filtering capacity. It readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in pollution of the ground water.

The land capability classification is IIe, and the Michigan soil management group is 2.5a. No woodland ordination symbol is assigned.

4A—Oshtemo sandy loam, 0 to 2 percent slopes. This nearly level, well drained soil is in broad areas on uplands. Individual areas are irregularly shaped and range from 20 to 300 acres in size.

Typically, the surface layer is dark brown sandy loam about 11 inches thick. The subsoil is about 31 inches thick. The upper part is brown and dark brown, friable sandy loam. The lower part is strong brown, very friable loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand that has dark brown bands of sandy loam. In some places the subsoil has more clay. In other places the surface layer is loamy sand.

Permeability is moderately rapid, and the available water capacity is moderate. Surface runoff is slow.

Most areas are used as cropland. A few are used as pasture or woodland.

This soil is fairly well suited to such crops as corn, soybeans, winter wheat, and alfalfa hay. The main management needs are measures that maintain the supply of soil moisture and the content of organic matter and help to control soil blowing. Examples are establishing field windbreaks, returning crop residue to the soil, and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface.

This soil is fairly well suited to pasture. The main concern in managing pastured areas is conserving moisture during dry periods, when the amount of soil moisture is insufficient for optimum plant growth. Incorporating animal manure and green manure crops into the surface layer increases the moisture supply.

If this soil is used as woodland, plant competition is the main management concern. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is well suited to building site development and septic tank absorption fields.

The land capability classification is IIIs, the woodland ordination symbol is 4A, and the Michigan soil management group is 3a.

4B—Oshtemo sandy loam, 2 to 6 percent slopes. This undulating, well drained soil is on broad slopes and low ridges and knolls in the uplands. Individual areas are irregularly shaped and range from 3 to 300 acres in size.

Typically, the surface layer is dark brown sandy loam about 11 inches thick. The subsoil is about 31 inches thick. The upper part is brown and dark brown, friable sandy loam. The lower part is strong brown, very friable loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand that has dark brown bands of sandy loam. In some places the subsoil has more clay. In other places the upper part of the subsoil is more sandy. In some areas the surface layer is loamy sand.

Included with this soil in mapping are small areas of the well drained Spinks soils. These soils are in landscape positions similar to those of the Oshtemo soil. They are sandy throughout. They make up about 6 percent of the unit.

Permeability is moderately rapid in the Oshtemo soil, and the available water capacity is moderate. Surface runoff is slow.

Most areas are used as cropland. A few are used as pasture or woodland.

This soil is fairly well suited to such crops as corn, soybeans, winter wheat, and alfalfa hay. The main management needs are measures that help to control water erosion and soil blowing and maintain the supply of soil moisture and the content of organic matter. Examples are stripcropping, growing cover crops, returning crop residue to the soil, and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface.

This soil is fairly well suited to pasture. The main concern in managing pastured areas is conserving moisture during dry periods, when the amount of soil moisture is insufficient for optimum plant growth. Incorporating animal manure and green manure crops into the surface layer increases the moisture supply.

If this soil is used as woodland, plant competition is the main management concern. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is well suited to building site development and septic tank absorption fields.

The land capability classification is IIIe, the woodland ordination symbol is 4A, and the Michigan soil management group is 3a.

4C—Oshtemo sandy loam, 6 to 12 percent slopes. This gently rolling, well drained soil is on ridges and knolls in the uplands. Individual areas are irregularly shaped and range from 10 to 40 acres in size.

Typically, the surface layer is dark brown sandy loam about 11 inches thick. The subsoil is about 31 inches thick. The upper part is brown and dark brown, friable sandy loam. The lower part is strong brown, very friable loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand that has dark brown bands of sandy loam. In places the subsoil has more clay. In some areas the surface layer is less than 5 inches thick. In other areas it is loamy sand.

Included with this soil in mapping are small areas of the well drained Spinks soils. These soils are in landscape positions similar to those of the Oshtemo soil. They are sandy throughout. They make up about 8 percent of the unit.

Permeability is moderately rapid in the Oshtemo soil, and the available water capacity is moderate. Surface runoff is medium.

Most areas are used as cropland. Some are used as pasture or woodland.

This soil is fairly well suited to such crops as corn, soybeans, winter wheat, and alfalfa hay. The main management needs are measures that help to control water erosion and soil blowing and maintain the supply of soil moisture and the content of organic matter. Examples are growing cover crops, returning crop residue to the soil, and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface.

This soil is well suited to pasture. The major management concerns are droughtiness and water erosion. Incorporating animal manure and green manure crops into the surface layer increases the moisture supply. Overgrazing during dry periods can destroy the plant cover. Rotation grazing and deferment of grazing during dry periods help to maintain the plant cover and thus reduce the susceptibility to erosion.

If this soil is used as woodland, plant competition is the main management concern. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is fairly well suited to building site development and septic tank absorption fields. The slope is the main limitation. Buildings should be designed so that they conform to the natural slope of

the land. Land shaping and installing the distribution lines across the slope help to ensure that septic tank absorption fields function properly.

The land capability classification is IIIe, the woodland ordination symbol is 4A, and the Michigan soil management group is 3a.

4D—Oshtemo sandy loam, 12 to 18 percent slopes. This hilly, well drained soil is on hillsides and ridges in the uplands. Individual areas are irregularly shaped and range from 5 to 25 acres in size.

Typically, the surface layer is dark brown sandy loam about 11 inches thick. The subsoil is about 31 inches thick. The upper part is brown and dark brown, friable sandy loam. The lower part is strong brown, very friable loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand that has dark brown bands of sandy loam. In some places the subsoil has more clay. In other places the surface layer is loamy sand.

Included with this soil in mapping are small areas of the well drained Spinks soils. These soils are in landscape positions similar to those of the Oshtemo soil. They are sandy throughout. They make up about 7 percent of the unit.

Permeability is moderately rapid in the Oshtemo soil, and the available water capacity is moderate. Surface runoff is rapid.

Most areas are wooded. Some are used as pasture.

Because of the slope, this soil is poorly suited to cropland, but such crops as corn, soybeans, winter wheat, and alfalfa hay can be grown. Water erosion, soil blowing, and droughtiness are the main management concerns. A system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface can help to prevent excessive soil loss. Crop rotations that include hay and small grain also help to prevent excessive soil loss. Returning crop residue to the soil and regularly adding other organic material improve fertility, maintain soil structure, and increase the available water capacity.

This soil is fairly well suited to pasture. The main concern in managing pastured areas is the erosion hazard. Maintaining an adequate plant cover by rotation grazing helps to control surface runoff and erosion.

The main concern in managing woodland is plant competition. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is poorly suited to building site development and septic tank absorption fields. The slope is the main limitation. Buildings should be designed so that they conform to the natural slope of the land. Land shaping is necessary in some areas. The distribution lines in septic tank absorption fields should be installed on the contour.

The land capability classification is IVe, the woodland ordination symbol is 4A, and the Michigan soil management group is 3a.

5B—Spinks loamy sand, 0 to 6 percent slopes. This nearly level and undulating, well drained soil is on flats and small ridges in the uplands. Individual areas are irregularly shaped and range from 3 to 300 acres in size.

Typically, the surface layer is dark brown loamy sand about 10 inches thick. The subsurface layer is yellowish brown, very friable loamy fine sand about 8 inches thick. The next 35 inches is yellowish brown and dark yellowish brown, very friable loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is brown sand. In some places the total thickness of the bands is less than 6 inches. In other places the lower part of the soil has more clay. In some areas the surface layer is fine sand.

Permeability is moderately rapid or rapid, and the available water capacity is low. Surface runoff is slow.

Most areas are used as cropland. A few are idle or are wooded.

This soil is fairly well suited to such crops as corn, soybeans, asparagus, and strawberries. The main management needs are measures that maintain the supply of soil moisture and the content of organic matter and help to control soil blowing. Examples are establishing field windbreaks, growing cover crops, wind stripcropping, returning crop residue to the soil, and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface. Irrigation can increase crop yields if the soil moisture level is low. If the soil is irrigated, water application rates should be regulated and equipment lanes should be seeded because of the hazard of erosion.

This soil is well suited to pasture. Droughtiness is the major management concern. Incorporating animal manure and green manure crops into the surface layer conserves moisture. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

If this soil is used as woodland, the major management concern is plant competition. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is well suited to building site development and septic tank absorption fields.

The land capability classification is IIIs, the woodland

ordination symbol is 4A, and the Michigan soil management group is 4a.

5C—Spinks loamy sand, 6 to 12 percent slopes. This gently rolling, well drained soil is on the sides of ridges and knolls in the uplands. Individual areas are irregularly shaped and range from 3 to 100 acres in size.

Typically, the surface layer is dark brown loamy sand about 10 inches thick. The subsurface layer is yellowish brown, very friable loamy fine sand about 8 inches thick. The next 35 inches is yellowish brown and dark yellowish brown loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is brown sand. In some places the total thickness of the bands is less than 6 inches. In some areas the surface layer is less than 4 inches thick. In other areas it is fine sand.

Included with this soil in mapping are small areas of soils where the slope is more than 12 percent. These soils make up about 7 percent of the unit.

Permeability is moderately rapid or rapid in the Spinks soil, and the available water capacity is low. Surface runoff is slow.

Most areas are used as woodland. Some of the acreage is cropland or pasture.

This soil is fairly well suited to corn. The main management needs are measures that help to control water erosion and soil blowing and maintain the supply of soil moisture and the content of organic matter. Examples are establishing field windbreaks, growing cover crops, returning crop residue to the soil, and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface. If the soil moisture level is low, irrigation can increase crop yields. If the soil is irrigated, water application rates should be regulated and equipment lanes should be seeded because of the hazard of erosion.

This soil is well suited to pasture. The major management concerns are droughtiness and the hazard of erosion. Incorporating animal manure into the surface layer conserves moisture. During the summer months when the soil moisture level is low, overgrazing can reduce the extent of the plant cover and cause erosion. Proper stocking rates, controlled grazing, and restricted use during dry periods help to maintain a good plant cover and thus help to control erosion.

The main concern in managing woodland is plant competition. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is fairly well suited to building site development and septic tank absorption fields. The slope is the main limitation. Buildings should be designed so that they conform to the natural slope of the land. Land shaping is necessary in some areas. Land shaping and installing the distribution lines across the slope help to ensure that septic tank absorption fields function properly.

The land capability classification is IIIe, the woodland ordination symbol is 4A, and the Michigan soil management group is 4a.

9A—Kalamazoo loam, 0 to 2 percent slopes. This nearly level, well drained soil is on broad upland flats. Individual areas are irregularly shaped and range from 20 to 300 acres in size.

Typically, the surface layer is dark grayish brown loam about 9 inches thick. The subsoil is about 33 inches thick. In sequence downward, it is dark brown, firm clay loam; strong brown, friable sandy clay loam; dark brown, friable gravelly sandy clay loam; dark brown, very friable sandy loam; and dark brown, very friable loamy sand. The substratum to a depth of about 60 inches is dark brown gravelly sand and dark yellowish brown sand. In some places the subsoil has less clay. In other places the upper part of the subsoil is silt loam. In some areas the surface layer is sandy loam.

Permeability is moderate in the upper part of the profile and rapid in the lower part. The available water capacity is moderate. Surface runoff is slow.

Most areas are used as cropland. Some are used as pasture or woodland.

This soil is well suited to such crops as corn, soybeans, winter wheat, and alfalfa hay. The major management concern is droughtiness. A system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface conserves moisture. If the soil moisture level is low, irrigation can increase crop yields. If the soil is irrigated, water application rates should be regulated and equipment lanes should be seeded because of the hazard of erosion.

This soil is well suited to pasture. The main concern in managing pastured areas is conserving moisture during dry periods, when the amount of soil moisture is insufficient for optimum plant growth. Rotation grazing or strip grazing and restricted use during dry periods help to maintain forage production.

If this soil is used as woodland, plant competition is the main management concern. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is well suited to building site development,

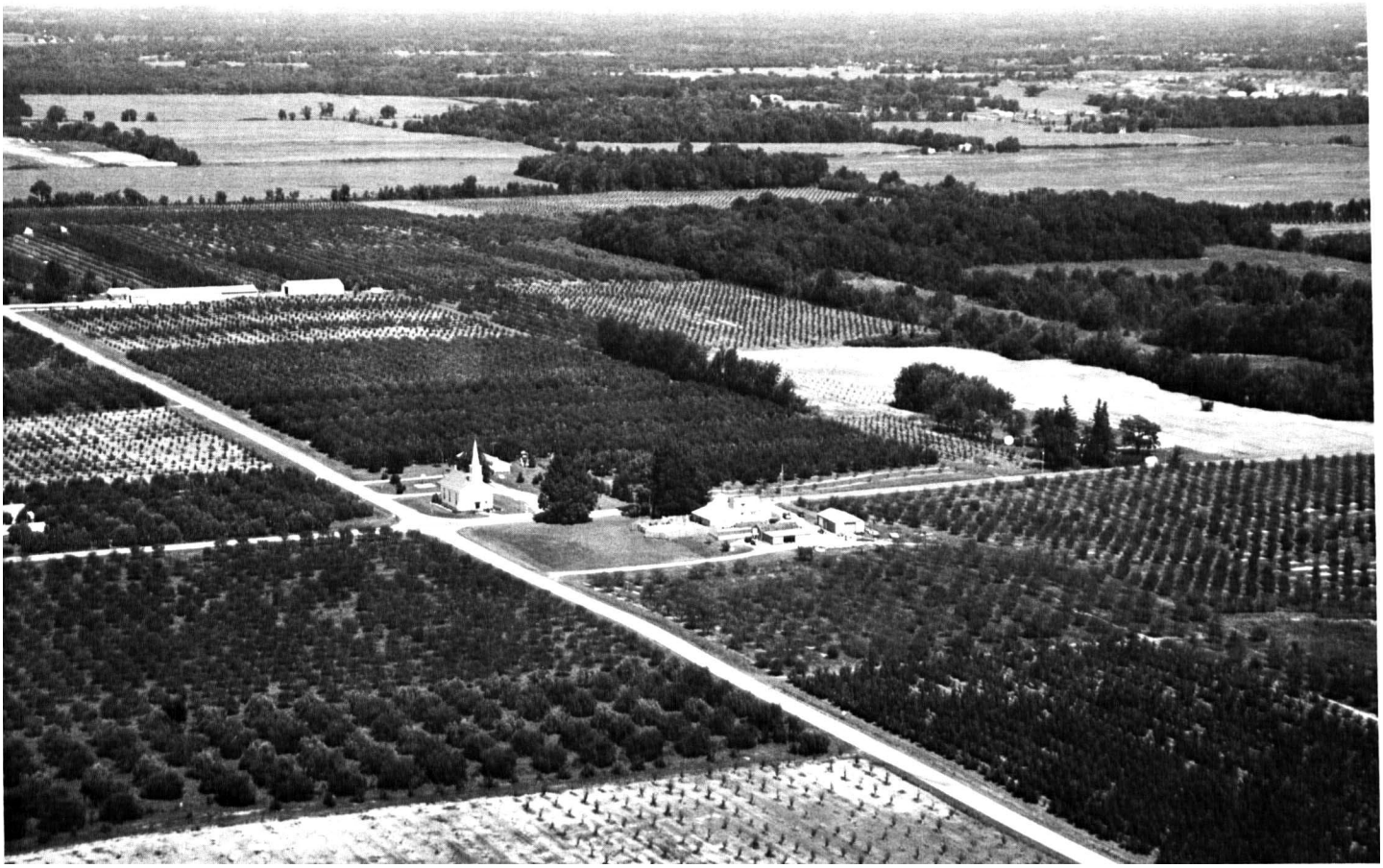

Figure 5.—An orchard in an area of Kalamazoo loam, 2 to 6 percent slopes.

but the shrink-swell potential is a moderate limitation. Widening the foundation trench and backfilling it with suitable coarse textured material minimize the structural damage caused by shrinking and swelling. The soil is suited to septic tank absorption fields, but it has a poor filtering capacity. It readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in pollution of the ground water.

The land capability classification is IIs, the woodland ordination symbol is 4A, and the Michigan soil management group is 3/5a.

9B—Kalamazoo loam, 2 to 6 percent slopes. This undulating, well drained soil is on low knolls and ridges in the uplands. Individual areas are irregularly shaped and range from 4 to 320 acres in size.

Typically, the surface layer is dark grayish brown loam about 9 inches thick. The subsoil is about 33 inches thick. In sequence downward, it is dark brown, firm clay loam; strong brown, friable sandy clay loam; dark brown, friable gravelly sandy clay loam; dark brown, very friable sandy loam; and dark brown, very friable loamy sand. The substratum to a depth of about 60 inches is dark brown gravelly sand and dark yellowish brown sand. In some places the subsoil has less clay. In other places the upper part of the subsoil is silt loam. In some areas the surface layer is sandy loam.

Permeability is moderate in the upper part of the profile and rapid in the lower part. The available water capacity is moderate. Surface runoff is slow.

Most areas are used as cropland. Some are used as pasture or woodland.

This soil is well suited to such crops as corn, soybeans, and apples (fig. 5). The main management needs are measures that help to control water erosion and maintain the supply of soil moisture. Examples are wind stripcropping, growing cover crops, and applying a

system of conservation tillage that leaves all or part of the crop residue on the surface. Irrigation may be needed in the areas used for corn. Regulating the rate of water application and seeding equipment lanes help to control erosion.

This soil is well suited to pasture. The main concern in managing pastured areas is conserving moisture during dry periods, when the amount of soil moisture is insufficient for optimum plant growth. Rotation grazing or strip grazing and restricted use during dry periods help to maintain forage production.

If this soil is used as woodland, plant competition is the main management concern. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is well suited to building site development, but the shrink-swell potential is a moderate limitation. Widening the foundation trench and backfilling it with suitable coarse textured material minimize the structural damage caused by shrinking and swelling. The soil is suited to septic tank absorption fields, but it has a poor filtering capacity. It readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in pollution of the ground water.

The land capability classification is IIe, the woodland ordination symbol is 4A, and the Michigan soil management group is 3/5a.

9C—Kalamazoo loam, 6 to 12 percent slopes. This gently rolling, well drained soil is on ridges and the sides of knolls in the uplands. Individual areas are irregularly shaped and range from 4 to 110 acres in size.

Typically, the surface layer is dark grayish brown loam about 9 inches thick. The subsoil is about 33 inches thick. In sequence downward, it is dark brown, firm clay loam; strong brown, friable sandy clay loam; dark brown, friable gravelly sandy clay loam; dark brown, very friable sandy loam; and dark brown, very friable loamy sand. The substratum to a depth of about 60 inches is dark brown gravelly sand and dark yellowish brown sand. In some places the subsoil has less clay. In other places it is exposed. In some areas the surface layer is sandy loam.

Permeability is moderate in the upper part of the profile and rapid in the lower part. The available water capacity is moderate. Surface runoff is medium.

Most areas are used as cropland. Some are used as pasture or woodland.

This soil is fairly well suited to such crops as corn, soybeans, and apples. The major management concern is water erosion. Wind stripcropping, cover crops, and a system of conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface help to control erosion. Irrigation may be needed in the areas used for corn. If the soil is irrigated, the water application rate should be carefully regulated and equipment lanes should be seeded because of the hazard of erosion.

This soil is well suited to pasture. The major management concerns are droughtiness and water erosion. Incorporating animal manure and green manure crops into the surface layer increases the moisture supply. Overgrazing during dry periods can destroy the plant cover. Rotation grazing and deferment of grazing during dry periods help to maintain the plant cover and thus reduce the susceptibility to erosion.

If this soil is used as woodland, plant competition is the main management concern. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is well suited to building site development, but the slope and the shrink-swell potential are moderate limitations. Buildings should be designed so that they conform to the natural slope of the land. Land shaping may be necessary in some areas. Widening the foundation trench and backfilling it with suitable coarse textured material minimize the structural damage caused by shrinking and swelling. The soil is suited to septic tank absorption fields, but a poor filtering capacity and the slope are limitations. The soil readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in pollution of the ground water. Land shaping and installing the distribution lines across the slope help to ensure that the absorption field functions properly.

The land capability classification is IIIe, the woodland ordination symbol is 4A, and the Michigan soil management group is 3/5a.

9D—Kalamazoo loam, 12 to 18 percent slopes. This hilly, well drained soil is on hillsides and ridges in the uplands. Individual areas are irregularly shaped and range from 5 to 30 acres in size.

Typically, the surface layer is dark grayish brown loam about 9 inches thick. The subsoil is about 33 inches thick. In sequence downward, it is dark brown, firm clay loam; strong brown, friable sandy clay loam; dark brown, friable gravelly sandy clay loam; dark brown, very friable sandy loam; and dark brown, very friable loamy sand. The substratum to a depth of about 60 inches is dark brown gravelly sand and dark yellowish brown sand. In some places the subsoil has less clay. In other places the surface layer is sandy loam.

Included with this soil in mapping are small areas of

the well drained Spinks soils. These soils are on the middle and lower parts of the landscape. They have more sand in the surface layer and subsoil than the Kalamazoo soil. Also included are small areas of soils that have a slope of 6 to 12 percent. Included soils make up about 13 percent of the unit.

Permeability is moderate in the upper part of the Kalamazoo soil and rapid in the lower part. The available water capacity is moderate. Surface runoff is medium.

Most areas are wooded. Some are used as pasture.

This soil is poorly suited to cropland, but such crops as corn, soybeans, winter wheat, and alfalfa hay can be grown. Water erosion is the main management concern. A system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface helps to prevent excessive soil loss. Crop rotations that include hay and small grain also help to prevent excessive soil loss.

This soil is fairly well suited to pasture. Water erosion is the major management concern. Maintaining an adequate plant cover by rotation grazing helps to control surface runoff and erosion.

The main concern in managing woodland is plant competition. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is poorly suited to building site development and septic tank absorption fields. The slope is the main limitation. Buildings should be designed so that they conform to the natural slope of the land. Land shaping is necessary in some areas. The distribution lines in septic tank absorption fields should be installed on the contour.

The land capability classification is IVe, the woodland ordination symbol is 4A, and the Michigan soil management group is 3/5a.

11—Edwards muck. This nearly level, very poorly drained soil is in depressions. It is frequently ponded. Individual areas are irregularly shaped and range from 5 to 50 acres in size.

Typically, the upper 12 inches is black muck. The next 10 inches is black and very dark gray, very friable muck. The substratum to a depth of about 60 inches is light brownish gray marl. In places the marl is underlain by mineral material below a depth of 36 inches.

Included with this soil in mapping are small areas of the very poorly drained Houghton and Palms mucks. These soils are in landscape positions similar to those of the Edwards soil. Houghton soils are muck to a depth of more than 51 inches. Palms soils are muck to a depth of 16 to 50 inches and are underlain by loamy material. Included soils make up about 11 percent of the unit.

Permeability is moderately slow to moderately rapid in the organic part of the Edwards soil. The available water capacity is high. Surface runoff is very slow or ponded. The seasonal high water table is near or above the surface from September through June.

Most areas support native vegetation, including trees. A few areas that have been drained are used for crops.

This soil is generally unsuited to cultivated crops. If drained, however, it can be used for such crops as corn, celery, and onions. The major management concerns are soil blowing and excess water. Field windbreaks and cover crops help to control soil blowing. A surface drainage system or subsurface tile is needed to reduce the wetness and control the ponding. Lift pumps are needed at the drainage outlets in some areas.

This soil is poorly suited to pasture. The major management concerns are wetness and compaction. Small surface ditches can reduce the wetness. Deferment of grazing during the wetter periods can help to keep the pasture in good condition.

If this soil is used as woodland, the major management concerns are the equipment limitation, the windthrow hazard, seedling mortality, and plant competition. Equipment should be used only when the ground is frozen. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard. After trees are cut, plant competition can prevent or delay natural regeneration unless precautionary meaures are applied. Special harvest methods may be needed to control undesirable plants. Trees generally are not planted on this soil because of a high seedling mortality rate, plant competition, and low productivity.

Because of the ponding and excess humus, this soil is generally unsuited to building site development and septic tank absorption fields.

The land capability classification is Vw, the woodland ordination symbol is 2W, and the Michigan soil management group is M/Mc.

12A—Brady sandy loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on plains in the uplands. Individual areas are irregularly shaped and range from 3 to 25 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 9 inches thick. The subsurface layer is brown, friable sandy loam about 6 inches thick. The subsoil is about 33 inches thick. It is mottled. The upper part is yellowish brown and brown, friable sandy loam. The lower part is yellowish brown, very friable loamy sand. The substratum to a depth of about 60

inches is yellowish brown, mottled sand. In places the upper part of the subsoil has no mottles. In some areas the surface layer is loamy sand.

Included with this soil in mapping are areas where the surface soil and subsoil contain more sand and areas where the subsoil consists of discontinuous bands. These areas are in landscape positions similar to those of the Brady soil. Also included are small areas of soils that have a slope of 2 to 4 percent. Included soils make up about 12 percent of the unit.

Permeability is moderately rapid in the Brady soil, and the available water capacity is moderate. Surface runoff is very slow. The seasonal high water table is 1 to 3 feet below the surface from November through May.

Most areas are used as cropland. A few are used as pasture or woodland.

This soil is well suited to such crops as corn, soybeans, winter wheat, and alfalfa hay. The wetness is a major management concern. A subsurface drainage system effectively removes excess water.

This soil is well suited to pasture. The main management concerns are removing excess water during wet periods and preventing excessive compaction. Grazing when the soil is too wet can cause compaction and can destroy forage plants. Proper stocking rates, rotation grazing or strip grazing, and restricted use during wet periods help to keep the pasture in good condition. Excess water can be removed by surface drains if drainage outlets are available.

The main concerns in managing woodland are the equipment limitation and plant competition. Ruts form easily if skidders are used when the soil is wet. Equipment should be used only when the soil is frozen or relatively dry. After trees are cut, plant competition can delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control undesirable plants. If trees are planted, site preparation by mechanical or chemical means generally is needed to control the competing plants.

This soil is poorly suited to building site development and septic tank absorption fields because of the wetness. A drainage system can help to lower the water table. Buildings with basements should be constructed on well compacted fill material, which raises the site. If the soil is used as a site for septic tank absorption fields, special construction measures, such as filling or mounding the site with suitable soil material, may be needed to raise the sewage disposal area above the water table.

The land capability classification is IIw, the woodland ordination symbol is 3W, and the Michigan soil management group is 3b.

15—Glendora muck. This nearly level, very poorly drained soil is on flood plains along rivers and creeks. It is frequently flooded. Individual areas are generally elongated and range from 3 to more than 200 acres in size.

Typically, the surface layer is black muck about 6 inches thick. The next layer is black mucky fine sandy loam about 3 inches thick. The upper part of the substratum is light brownish gray loamy fine sand. The lower part to a depth of about 60 inches is grayish brown sand.

Included with this soil in mapping are some small areas of very poorly drained soils. These soils have more clay in the subsoil than the Glendora soil. They are in landscape positions similar to those of the Glendora soil. Also included are areas of hilly or steep soils bordering the uplands. Included soils make up about 5 to 15 percent of the unit.

Permeability is rapid in the Glendora soil, and the available water capacity is moderate. Surface runoff is very slow or ponded. The seasonal high water table is within a depth of 1 foot from November through June.

Most areas are wooded. Some of the acreage is idle land.

Because of the wetness and the frequent flooding, this soil is generally unsuited to cropland. Draining the soil is difficult because the water table is often near the water level in the adjacent rivers or creeks. The soil is poorly suited to pasture. Water pollution can occur unless access of livestock to streams and rivers is restricted and runoff is diverted.

If this soil is used as woodland, the main management concerns are the equipment limitation, the windthrow hazard, seedling mortality, and plant competition. Equipment should be used only when the ground is frozen. Because of the seasonal high water table, trees on this soil are shallow rooted and can be blown down during periods of high wind. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard. Trees generally are not planted on this soil because of the wetness and the hazard of flooding.

This soil is not suited to building site development or septic tank absorption fields because of the hazard of flooding.

The land capability classification is VIw, the woodland ordination symbol is 3W, and the Michigan soil management group is L-4c.

16B—Ormas loamy sand, 0 to 6 percent slopes. This nearly level and undulating, well drained soil is on

flats and small ridges in the uplands. Individual areas are irregularly shaped and range from 7 to 160 acres in size.

Typically, the surface layer is dark brown loamy sand about 9 inches thick. The subsoil is about 37 inches thick. The upper part is yellowish brown, very friable loamy sand. The lower part is dark yellowish brown, friable sandy loam and yellowish brown, friable gravelly sandy loam. The substratum to a depth of about 60 inches is yellowish brown gravelly loamy sand. In some places the subsoil or substratum is banded. In other places the surface layer is fine sand or sand.

Included with this soil in mapping are small areas of the well drained Kalamazoo soils. These soils are in landscape positions similar to those of the Ormas soil. They have more clay in the subsoil than the Ormas soil. They make up about 10 percent of the unit.

Permeability is moderately rapid in the upper part of the Ormas soil and very rapid in the lower part. The available water capacity is low. Surface runoff is slow.

Most areas are used as cropland. A few are used as pasture or woodland.

This soil is fairly well suited to such crops as corn, asparagus, and strawberries. The main management needs are measures that maintain the supply of soil moisture and the content of organic matter and help to control soil blowing. Examples are establishing field windbreaks, wind stripcropping, growing cover crops, returning crop residue to the soil, and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface. Irrigation may be needed in the areas used for corn or strawberries. If the soil is irrigated, water application rates should be regulated and equipment lanes should be seeded because of the hazard of erosion.

This soil is well suited to pasture. Droughtiness is the major management concern. Incorporating animal manure and green manure crops into the surface layer conserves moisture.

If this soil is used as woodland, the major management concerns are seedling mortality and plant competition. The seedling survival rate can be increased by applying special site preparation methods, such as furrowing or applying herbicide before planting, and by selecting container-grown nursery stock for planting. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is well suited to building site development. It is suited to septic tank absorption fields, but it has a poor filtering capacity. It readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in pollution of the ground water.

The land capability classification is IIIe, the woodland ordination symbol is 3S, and the Michigan soil management group is 4a.

16C—Ormas loamy sand, 6 to 12 percent slopes. This gently rolling, well drained soil is on the uneven side slopes of ridges and knolls in the uplands. Individual areas are irregularly shaped and range from 3 to 25 acres in size.

Typically, the surface layer is dark brown loamy sand about 9 inches thick. The subsoil is about 37 inches thick. The upper part is yellowish brown, very friable loamy sand. The lower part is dark yellowish brown, friable sandy loam and yellowish brown, friable gravelly sandy loam. The substratum to a depth of about 60 inches is yellowish brown gravelly loamy sand. In some places the subsoil or substratum is banded. In other places the surface layer is fine sand or sand.

Included with this soil in mapping are small areas of the well drained Kalamazoo soils. These soils are in landscape positions similar to those of the Ormas soil. They have more clay in the subsoil than the Ormas soil. They make up about 8 percent of the unit.

Permeability is moderately rapid in the upper part of the Ormas soil and very rapid in the lower part. The available water capacity is low. Surface runoff is slow.

Most areas are used as cropland. Some are used as woodland.

This soil is fairly well suited to such crops as corn and asparagus. The main management needs are measures that help to control water erosion and soil blowing and that maintain the supply of soil moisture and the content of organic matter. Examples are establishing field windbreaks, wind stripcropping, growing cover crops, constructing diversions, incorporating crop residue into the surface layer, growing green manure crops, establishing grassed waterways, and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface. Irrigation can increase crop yields if the soil moisture level is low. If the soil is irrigated, water application rates should be regulated and equipment lanes should be seeded because of the hazard of erosion.

This soil is well suited to pasture. The major management concerns are droughtiness and water erosion. Incorporating animal manure and green manure crops into the surface layer increases the moisture supply. Overgrazing during dry periods can destroy the plant cover. Rotation grazing and deferment of grazing during dry periods help to maintain the plant cover and thus reduce the hazard of erosion.

If this soil is used as woodland, the major

management concerns are seedling mortality and plant competition. The seedling survival rate can be increased by applying special site preparation methods, such as furrowing or applying herbicide before planting, and by selecting container-grown nursery stock for planting. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is fairly well suited to building site development and septic tank absorption fields. The slope is the main limitation. Buildings should be designed so that they conform to the natural slope of the land. Land shaping and installing the distribution lines across the slope help to ensure that absorption fields function properly. The soil readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in pollution of the ground water.

The land capability classification is IIIe, the woodland ordination symbol is 3S, and the Michigan soil management group is 4a.

18—Barry loam. This nearly level, poorly drained soil is in depressions and drainageways. It is subject to ponding. Individual areas are elongated or irregularly shaped and range from 3 to 50 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsoil is about 32 inches thick. It is mottled and friable. The upper part is very dark gray silt loam, the next part is gray clay loam and sandy clay loam, and the lower part is gray sandy loam. The substratum to a depth of about 60 inches is brown, mottled sandy loam stratified with loamy sand and sandy clay loam. In some places the substratum is stratified silt loam and fine sandy loam. In other places the surface layer is silt loam or sandy loam.

Included with this soil in mapping are small areas of poorly drained soils. These soils have more clay in the subsoil than the Barry soil and have an unstratified substratum. They are in landscape positions similar to those of the Barry soil. They make up 6 to 15 percent of the unit.

Permeability and the available water capacity are moderate in the Barry soil. Surface runoff is slow. The seasonal high water table is near or above the surface from November through May.

In most areas this soil is used as woodland. Some areas are used as cropland or pasture.

If drained, this soil is well suited to such crops as corn, soybeans, winter wheat, and alfalfa hay. The major management concern is excess water. A surface drainage system and subsurface tile drains are needed to reduce the wetness. Suitable filtering material is needed to keep subsurface tile lines from becoming clogged with fine sand, silt, and clay.

This soil is well suited to pasture. The major management concerns are excess water and deterioration of tilth. Grazing when the soil is wet can cause surface compaction and poor tilth. Restricted or deferred grazing during wet periods helps to maintain good tilth.

The main concerns in managing woodland are the equipment limitation, the windthrow hazard, seedling mortality, and plant competition. Equipment should be used only when the soil is frozen or relatively dry. Because of the seasonal high water table, trees on this soil are shallow rooted and can be blown down during periods of high wind. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard. After trees are cut, plant competition can prevent or delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control undesirable plants. Because of a high seedling mortality rate, plant competition, and low productivity, trees generally are not planted on this soil.

Because of the ponding, this soil generally is not suited to building site development or septic tank absorption fields.

The land capability classification is IIw, the woodland ordination symbol is 2W, and the Michigan soil management group is 2.5c-s.

19—Houghton muck. This nearly level, very poorly drained soil is in depressions and along drainageways in old lakebeds. It is frequently ponded. Individual areas are irregularly shaped and range from 3 to 350 acres in size.

Typically, the surface tier is black muck about 15 inches thick. Below this to a depth of about 60 inches is dark reddish brown, friable muck.

Included with this soil in mapping are small areas of very poorly drained Adrian, Gilford, and Palms soils. Adrian and Palms soils are in positions on the landscape similar to those of the Houghton soil. They have mineral material within a depth of 50 inches. Gilford soils border the edges of the mapped areas. They are mineral soils. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderately slow to moderately rapid in the Houghton soil, and the available water capacity is high. Surface runoff is very slow or ponded. The seasonal high water table is near or above the surface from September through June.

Most areas are wooded. Some areas that have been drained are farmed.

This soil is generally unsuited to cultivated crops. If drained, it can be used for such crops as corn and for

Figure 6.—An area of Houghton muck. Trees do not grow well on this soil because of the wetness.

specialty crops, such as radishes and carrots. The major management concerns are soil blowing and excess water. Field windbreaks and cover crops help to control soil blowing. A surface drainage system or subsurface tile is needed to reduce the wetness and control the ponding. Lift pumps may be needed at the drainage outlets in some areas.

This soil is poorly suited to pasture. The major management concerns are wetness and compaction. Small surface ditches can reduce the wetness. Deferment of grazing during wet periods helps to prevent compaction and helps to keep the pasture in good condition.

If this soil is used as woodland, the major management concerns are the equipment limitation, the windthrow hazard, seedling mortality, and plant competition. Equipment should be used only when the ground is frozen. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard. After trees are cut, plant competition can prevent or delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control undesirable plants. Because of a high seedling mortality rate, plant competition, and low productivity, trees generally are not planted on this soil (fig. 6).

Because of the ponding and excess humus, this soil is generally unsuited to building site development and septic tank absorption fields.

The land capability classification is Vw, the woodland ordination symbol is 2W, and the Michigan soil management group is Mc.

20A—Bronson loamy sand, 0 to 3 percent slopes. This nearly level, moderately well drained soil is on flats and in slight depressions. Individual areas are irregularly shaped and range from 10 to 80 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 10 inches thick. The

subsurface layer is brown, very friable loamy sand about 8 inches thick. The upper part of the subsoil is dark yellowish brown, friable sandy loam. The next part is brown and dark brown, friable sandy loam. The lower part to a depth of about 62 inches is dark yellowish brown, mottled, very friable loamy sand that has thin bands of strong brown sandy loam. In some places the upper part of the subsoil is mottled. In other places the surface layer is sandy loam.

Included with this soil in mapping are areas of moderately well drained and somewhat poorly drained soils that have a sandy surface layer and subsoil. The moderately well drained soils are in landscape positions similar to those of the Bronson soil. The somewhat poorly drained soils are in the slightly lower landscape positions. Included soils make up 8 to 20 percent of the unit.

Permeability is moderately rapid in the Bronson soil, and the available water capacity is moderate. Surface runoff is slow. The seasonal high water table is at a depth of 2.0 to 3.5 feet from November through May.

Most areas are used as cropland. A few are used as woodland.

This soil is well suited to such crops as corn, soybeans, winter wheat, alfalfa hay, and strawberries. The main management needs are measures that maintain the supply of soil moisture and the content of organic matter and help to control soil blowing. Examples are growing cover crops, returning crop residue to the soil, and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface. Irrigation can increase crop yields if the soil moisture level is low. If the soil is irrigated, water application rates should be regulated and equipment lanes should be seeded because of the hazard of erosion.

This soil is well suited to pasture. Droughtiness is the major management concern. Incorporating animal manure and green manure crops into the surface layer conserves moisture.

If this soil is used as woodland, the major management concern is plant competition. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is well suited to dwellings without basements, but it is poorly suited to dwellings with basements because of the wetness. It is poorly suited to septic tank absorption fields because of the wetness and a poor filtering capacity. Surface or subsurface drains help to lower the water table. Well compacted fill material is needed to raise building sites. On sites for septic tank absorption fields, special construction measures, such as filling or mounding with suitable soil material, may be necessary to raise the sewage disposal area above the water table.

The land capability classification is IIs, the woodland ordination symbol is 4A, and the Michigan soil management group is 3a.

24—Adrian muck. This nearly level, very poorly drained soil is in depressions and drainageways and on flood plains. It is frequently ponded. Individual areas are irregularly shaped and range from 5 to 125 acres in size.

Typically, the surface tier is black muck about 9 inches thick. Below this is black, friable muck about 11 inches thick. The substratum to a depth of about 60 inches is light olive brown fine sand and brown sand. In some places the organic layer is 7 to 15 inches thick. In other places the substratum is sandy loam.

Included with this soil in mapping are small areas of the very poorly drained Gilford and Houghton soils. Gilford soils are near edges of the mapped areas. They are mineral soils. Houghton soils are muck to a depth of more than 51 inches. They are in landscape positions similar to those of the Adrian soil. Included soils make up about 13 percent of the unit.

Permeability is moderately slow to moderately rapid in the organic part of the Adrian soil and rapid in the sandy material. The available water capacity is high. Surface runoff is very slow or ponded. The seasonal high water table is near or above the surface from November through May.

Most areas are wooded. Some of the acreage is idle land, and some has been drained and is used as cropland.

This soil is generally unsuited to cultivated crops. If drained, it can be used for such crops as corn, carrots, radishes, and blueberries. The major management concerns are soil blowing and excess water. Field windbreaks and cover crops help to control soil blowing. A surface drainage system or subsurface tile is needed to reduce the wetness and control the ponding. Lift pumps may be needed at the drainage outlets in some areas.

This soil is poorly suited to pasture. The major management concerns are wetness and compaction. Small surface ditches can reduce the wetness. Deferment of grazing during wet periods helps to prevent compaction and helps to keep the pasture in good condition.

If this soil is used as woodland, the major management concerns are the equipment limitation, the windthrow hazard, seedling mortality, and plant competition. Equipment should be used only when the ground is frozen. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce

the windthrow hazard. After trees are cut, plant competition can prevent or delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control undesirable plants. Because of a high seedling mortality rate, plant competition, and low productivity, trees generally are not planted on this soil.

Because of the ponding and excess humus, this soil is generally unsuited to building site development and septic tank absorption fields.

The land capability classification is Vw, the woodland ordination symbol is 2W, and the Michigan soil management group is M/4c.

26C—Riddles fine sandy loam, 6 to 12 percent slopes. This gently rolling, well drained soil is on the sides of ridges and knolls on till plains in the uplands. Individual areas are irregularly shaped and range from 6 to 20 acres in size.

Typically, the surface layer is dark brown fine sandy loam about 7 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is brown, firm clay loam and loam. The lower part is brown and yellowish brown, friable sandy loam. In some places gravelly loamy sand is below a depth of 50 inches. In other places the subsoil has slightly less clay. In some areas the surface layer is sandy loam or loam.

Included with this soil in mapping are small areas of the moderately well drained Cassopolis soils. These soils are slightly lower on the landscape than the Riddles soil. Also included are small areas of soils in which the subsoil is exposed. These soils do not have the nutrients needed for good plant growth. They are in landscape positions similar to those of the Riddles soil. Included soils make up about 5 percent of the unit.

Permeability is moderate in the Riddles soil, and the available water capacity is high. Surface runoff is medium.

Most areas are used as cropland. Some are used as pasture or woodland.

This soil is fairly well suited to such crops as corn, winter wheat, and soybeans. Water erosion is the major hazard. It can be controlled by planting cover crops and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface.

This soil is well suited to pasture. The main concern in managing pastured areas is the erosion hazard. Grazing after heavy rains can result in surface compaction and excessive erosion. Rotation grazing and deferment of grazing during wet periods help to keep the pasture in good condition and reduce the susceptibility to erosion.

The main concern in managing woodland is plant competition. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is fairly well suited to building site development. The slope and the shrink-swell potential are limitations. Buildings should be designed so that they conform to the natural slope of the land. In some areas land shaping is needed. Replacing the upper layers of the soil with suitable fill material can help to overcome the shrink-swell potential. The soil is suited to septic tank absorption fields, but the slope is a limitation. Land shaping and installing the distribution lines across the slope help to ensure that the absorption field functions properly.

The land capability classification is IIIe, the woodland ordination symbol is 5A, and the Michigan soil management group is 2.5a.

26D—Riddles fine sandy loam, 12 to 18 percent slopes. This hilly, well drained soil is on hillsides and ridges in the uplands. Individual areas are irregularly shaped and range from 10 to 20 acres in size.

Typically, the surface layer is dark brown fine sandy loam about 7 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is brown, firm clay loam and loam. The lower part is brown and yellowish brown, friable sandy loam. In some places gravelly loamy sand is below a depth of 50 inches. In other places the surface layer is sandy loam or loam.

Included with this soil in mapping are small areas of soils that have a slope of 3 to 6 percent. These soils make up about 5 percent of the unit.

Permeability is moderate in the Riddles soil, and the available water capacity is high. Surface runoff is rapid.

Most areas are wooded. Some are used as pasture.

This soil is poorly suited to cropland because of the slope, but such crops as corn, soybeans, winter wheat, and alfalfa hay can be grown. Water erosion is the major hazard. It can be controlled by planting cover crops and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface.

This soil is fairly well suited to pasture. The main concern in managing pastured areas is the erosion hazard. Maintaining an adequate plant cover by rotation grazing helps to control surface runoff and erosion.

The main concern in managing woodland is plant competition. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is poorly suited to building site development and septic tank absorption fields. The slope is the main

limitation. Buildings should be designed so that they conform to the natural slope of the land. Land shaping is necessary in some areas. The distribution lines in septic tank absorption fields should be installed on the contour.

The land capability classification is IVe, the woodland ordination symbol is 5A, and the Michigan soil management group is 2.5a.

26E—Riddles fine sandy loam, 18 to 35 percent slopes. This steep, well drained soil is on hillsides and ridges in the uplands. Individual areas are irregularly shaped and range from 4 to 20 acres in size.

Typically, the surface layer is dark brown fine sandy loam about 7 inches thick. The upper part of the subsoil is brown, firm clay loam and loam. The lower part to a depth of about 60 inches is brown and yellowish brown, friable sandy loam. In places the surface layer is sandy loam or loam.

Included with this soil in mapping are small areas of soils that have a slope of 3 to 12 percent. Also included are areas where the subsoil is exposed. Included soils make up about 8 percent of the unit.

Permeability is moderate in the Riddles soil, and the available water capacity is high. Surface runoff is rapid.

Most areas are wooded. Some of the acreage is idle grassland.

This soil is unsuitable as cropland and is poorly suited to pasture. The major management concern in pastured areas is the erosion hazard. Maintaining an adequate plant cover by rotation grazing helps to control surface runoff and erosion.

If this soil is used as woodland, the major management concerns are the equipment limitation, the erosion hazard, and plant competition. Because of the erosion hazard, logging roads should be built on the contour and water should be removed by water bars, out-sloping road surfaces, culverts, and drop structures. Landings and skid roads should be seeded after the trees are logged. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is generally unsuited to building site development and septic tank absorption fields because of the slope. Overcoming this limitation is extremely difficult.

The land capability classification is VIe, the woodland ordination symbol is 5R, and the Michigan soil management group is 2.5a.

27A—Tedrow loamy sand, 0 to 3 percent slopes. This nearly level, somewhat poorly drained soil is in slight depressions. Individual areas are irregularly shaped and range from 2 to 20 acres in size.

Typically, the surface layer is dark brown loamy sand about 9 inches thick. The subsoil is about 25 inches thick. It is mottled. The upper part is strong brown, very friable loamy sand. The lower part is strong brown and pale brown, loose sand. The substratum to a depth of about 60 inches is light yellowish brown and pale brown sand. In some places the subsoil is more gray. In other places it has bands of loamy sand and sandy loam. In some areas the surface layer is fine sand or loamy fine sand.

Permeability is rapid, and the available water capacity is low. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 2 feet from January through April.

Most of the acreage is farmed. Some areas are used as woodland or pasture.

This soil is well suited to such crops as strawberries and is fairly well suited to corn, soybeans, and winter wheat. The major management concerns are excess water, soil blowing, and midsummer droughtiness. Surface drains and subsurface tile reduce the wetness. Establishing field windbreaks, wind stripcropping, returning crop residue to the soil, adding animal manure, plowing green manure crops under, and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help to control soil blowing and conserve moisture.

This soil is fairly well suited to pasture. The wetness is the major management concern. Grazing during wet periods can result in poor tilth. Restricted grazing during wet periods helps to prevent deterioration of tilth.

The main concerns in managing woodland are the equipment limitation, seedling mortality, and plant competition. Equipment should be used only when the soil is dry or frozen. The seedling survival rate can be increased by applying special site preparation methods, such as furrowing, and by selecting container-grown nursey stock for planting. After trees are cut, plant competition can delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control undesirable plants. These plants can be controlled by mechanical or chemical means.

This soil is poorly suited to building site development. The major management concern is the wetness. A surface drainage system or subsurface tile helps to lower the water table. Buildings should be constructed on well compacted fill material, which raises the site. Because of the wetness and a poor filtering capacity, the soil is poorly suited to septic tank absorption fields. It readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in

pollution of the ground water. Special construction methods, such as filling or mounding with less porous material, may be needed to raise the absorption field above the water table.

The land capability classification is IIIs, the woodland ordination symbol is 2S, and the Michigan soil management group is 4b.

28A—Teasdale fine sandy loam, 0 to 3 percent slopes. This nearly level, somewhat poorly drained soil is on low ridges and in broad areas on till plains. Individual areas are irregularly shaped and range from 5 to 800 acres in size.

Typically, the surface layer is dark brown, fine sandy loam about 9 inches thick. The subsurface layer is brown, friable fine sandy loam about 8 inches thick. The next 14 inches is dark yellowish brown loam and brown fine sandy loam. The subsoil is yellowish brown, mottled loam about 17 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled fine sandy loam. In some places the subsoil has more clay. In other places the surface layer is sandy loam or loam.

Included with this soil in mapping are small areas of poorly drained soils in depressions. These soils have a stratified substratum. Also included are small areas of the moderately well drained Cassopolis soils on low knolls and ridges. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Teasdale soil, and the available water capacity is high. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 2 feet from November through May.

Most areas are used as cropland. Some are used as pasture or woodland.

This soil is well suited to such crops as corn, soybeans, winter wheat, and alfalfa hay. The main management needs are measures that help to control water erosion, remove excess water during wet periods, and maintain good tilth. Cover crops and a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help to control water erosion. A combination of surface and subsurface drains reduces the wetness. Good tilth can be maintained by restricting fieldwork during wet periods and by applying a system of conservation tillage.

This soil is well suited to pasture. The main management concerns are removing excess water during wet periods and preventing excessive compaction. Grazing when the soil is too wet can cause compaction and can destroy forage plants. Proper stocking rates, rotation grazing or strip grazing, and restricted use during wet periods help to keep the pasture in good condition. Excess water can be removed by surface drains if drainage outlets are available.

The main concerns in managing woodland are the equipment limitation and plant competition. Ruts form easily if skidders are used when the soil is wet. Equipment should be used only when the soil is frozen or relatively dry. After trees are cut, plant competition can delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control undesirable plants. These plants can be controlled by mechanical or chemical means.

This soil is poorly suited to building site development and septic tank absorption fields because of the wetness. A drainage system can help to lower the water table on building sites. Buildings with basements should be constructed on well compacted fill material, which raises the site. If the soil is used as a site for septic tank absorption fields, special construction measures, such as filling or mounding the site with suitable soil material, may be needed to raise the sewage disposal area above the water table.

The land capability classification is IIw, the woodland ordination symbol is 4W, and the Michigan soil management group is 2.5b.

29—Palms muck. This nearly level, very poorly drained soil is in swamps, along drainageways and flood plains, and in depressions on uplands. It is subject to ponding. Individual areas are irregularly shaped and range from 6 to 120 acres in size.

Typically, the surface tier is black muck about 12 inches thick. The lower tier is dark reddish brown, friable muck about 14 inches thick. The substratum extends to a depth of about 60 inches. It is light brownish gray, stratified fine sandy loam, loamy fine sand, and sandy clay loam in the upper part; grayish brown loamy sand in the next part; and grayish brown and pale olive sandy loam in the lower part. In some places the muck is less than 16 inches thick. In other places the substratum is sand.

Included with this soil in mapping are small areas of the very poorly drained Houghton soils. These soils are in landscape positions similar to those of the Palms soil. They are muck to a depth of more than 51 inches. They make up about 13 percent of the unit.

Permeability is moderately slow to moderately rapid in the organic part of the Palms soil and moderate or moderately slow in the loamy material. The available water capacity is high. Surface runoff is very slow or ponded. The seasonal high water table is near or above the surface from November through May.

Most areas are wooded. Some areas that have been drained are used for specialty crops.

This soil is generally unsuited to cultivated crops. If drained, it can be used for such crops as corn, celery, and onions. The major management concerns are soil blowing and excess water. Field windbreaks and cover crops help to control soil blowing. A surface drainage system or subsurface tile is needed to reduce the wetness and control the ponding. Lift pumps may be needed at the drainage outlets in some areas.

This soil is poorly suited to pasture. The major management concerns are wetness and compaction. Small surface ditches can reduce the wetness. Deferment of grazing during the wetter periods can help to keep the pasture in good condition.

If this soil is used as woodland, the major management concerns are the equipment limitation, the windthrow hazard, seedling mortality, and plant competition. Equipment should be used only when the ground is frozen. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard. After trees are cut, plant competition can prevent or delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control undesirable plants. Trees generally are not planted on this soil because of a high seedling mortality rate, plant competition, and low productivity.

Because of the ponding and excess humus, this soil is generally unsuited to building site development and septic tank absorption fields.

The land capability classification is Vw, the woodland ordination symbol is 2W, and the Michigan soil management group is M/3c.

30A—Elston sandy loam, 0 to 2 percent slopes. This nearly level, well drained soil is on broad upland flats. Individual areas are irregularly shaped and range from 5 to 900 acres in size.

Typically, the surface layer is black sandy loam about 14 inches thick. The subsoil is about 27 inches thick. The upper part is dark yellowish brown, friable sandy clay loam. The next part is dark yellowish brown, very friable sandy loam. The lower part is dark brown, very friable loamy sand. The substratum to a depth of about 60 inches is strong brown and yellowish brown sand. In some places the surface layer is less than 10 inches thick. In other places it is loam. In some areas the subsoil has more clay.

Permeability is moderately rapid, and the available water capacity is moderate. Surface runoff is slow.

This soil is used mainly as cropland. It is well suited to such crops as corn, soybeans, and winter wheat. The main management needs are measures that maintain the supply of soil moisture and the content of organic matter and help to control soil blowing. Examples are establishing field windbreaks, returning crop residue to the soil, and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface.

This soil is well suited to pasture. The main concern in managing pastured areas is conserving moisture during dry periods, when the amount of soil moisture is insufficient for optimum plant growth. Incorporating animal manure and green manure crops into the surface layer increases the moisture supply.

This soil is well suited to building site development. It is suited to septic tank absorption fields, but it has a poor filtering capacity. It readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in pollution of the ground water.

The land capability classification is IIs, and the Michigan soil management group is 2.5a. No woodland ordination symbol is assigned.

30B—Elston sandy loam, 2 to 6 percent slopes. This undulating, well drained soil is on low knolls, side slopes, and ridges in the uplands. Individual areas are irregularly shaped and range from 5 to 220 acres in size.

Typically, the surface layer is black sandy loam about 14 inches thick. The subsoil is about 27 inches thick. The upper part is dark yellowish brown, friable sandy clay loam. The next part is dark yellowish brown, very friable sandy loam. The lower part is dark brown, very friable loamy sand. The substratum to a depth of about 60 inches is strong brown and yellowish brown sand. In some places the surface layer is less than 10 inches thick. In other places the subsoil has more clay. In some areas the surface layer is loam.

Permeability is moderately rapid, and the available water capacity is moderate. Surface runoff is slow.

This soil is used mainly as cropland. It is well suited to such crops as corn, soybeans, and winter wheat. The main management needs are measures that maintain the supply of soil moisture and the content of organic matter and help to control water erosion and control soil blowing. Examples are wind stripcropping, growing cover crops, returning crop residue to the soil, and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface.

This soil is well suited to pasture. The main concern in managing pastured areas is conserving moisture during dry periods, when the amount of soil moisture is insufficient for optimum plant growth. Incorporating animal manure and green manure crops into the surface layer increases the moisture supply.

This soil is well suited to building site development. It is suited to septic tank absorption fields, but it has a

Figure 7.—An area from which sand and gravel are being mined.

poor filtering capacity. It readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in pollution of the ground water.

The land capability classification is IIe, and the Michigan soil management group is 2.5a. No woodland ordination symbol is assigned.

34—Pits. This map unit consists of excavations from which soil and the underlying sand and gravel have been removed. In areas where the excavations are deeper than the water table, ponding frequently occurs. Individual areas range from 3 to 60 acres in size.

Most areas are still mined for sand and gravel (fig. 7). This unit is unsuitable for cropland, pasture, and woodland. It varies too greatly to be rated for other uses. The ponds that have been created in the pits are used as watering holes by many species of wildlife. Some pits contain small amounts of trash and rubbish. Onsite investigation is needed to determine the suitability for specific uses.

This map unit is not assigned to interpretive groups.

36—Gilford sandy loam. This nearly level, very poorly drained soil is in depressions and drainageways. It is subject to ponding. Individual areas are irregularly shaped and range from 5 to 150 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 10 inches thick. The subsoil is about 12 inches thick. It is light brownish gray, mottled, friable sandy loam. The substratum to a depth of about 60 inches is light brownish gray and brown, mottled loamy sand. In some places the subsoil has less clay. In other places it has thin layers of clay loam or silty clay loam. In some areas the surface layer is loam.

Permeability is moderately rapid, and the available water capacity is moderate. Surface runoff is very slow

or ponded. The seasonal high water table is near or above the surface from December through May.

Most areas are wooded. A few have been drained and are used for corn or soybeans. Because of the wetness, this soil is generally unsuitable for cultivated crops. Drainage outlets are not available in most areas.

This soil is poorly suited to pasture. The major management concerns are excess water and deterioration of tilth. Grazing when the soil is wet can cause surface compaction and poor tilth. Restricted or deferred grazing during wet periods helps to maintain good tilth.

The main concerns in managing woodland are the equipment limitation, the windthrow hazard, seedling mortality, and plant competition. Equipment should be used only when the soil is frozen or relatively dry. Because of the seasonal high water table, trees on this soil are shallow rooted and can be blown down during periods of high wind. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard. After trees are cut, plant competition can prevent or delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control undesirable plants. Trees generally are not planted on this soil because of a high seedling mortality rate, plant competition, and low productivity.

This soil generally is not suited to building site development or septic tank absorption fields because of the ponding.

The land capability classification is Vw, the woodland ordination symbol is 2W, and the Michigan soil management group is 3/5c.

37B—Brems loamy sand, 0 to 6 percent slopes. This nearly level and undulating moderately well drained soil is in low depressions. Individual areas are irregularly shaped and range from 3 to 150 acres in size.

Typically, the surface layer is dark brown loamy sand about 9 inches thick. The subsoil is about 42 inches thick. The upper part is yellowish brown, very friable loamy sand. The lower part is strong brown, mottled, loose sand. The substratum to a depth of about 60 inches is very pale brown, mottled fine sand. In some places the subsoil has bands of loamy sand. In other places the surface layer is sand.

Permeability is rapid, and the available water capacity is low. Surface runoff is very slow. The seasonal high water table is at a depth of 2 to 3 feet from January through April.

Most areas are farmed. Some are used as pasture or woodland.

This soil is poorly suited to such crops as corn, small grain, soybeans, and alfalfa hay. It is fairly well suited to specialty crops, such as strawberries and blueberries. The main management needs are measures that maintain the supply of soil moisture and help to control soil blowing. Examples are establishing field windbreaks, growing cover crops, stripcropping, returning crop residue to the soil, and applying a system of conservation tillage that leaves all or part of the crop residue on the surface. Irrigation can increase crop yields if the soil moisture level is low. If the soil is irrigated, water application rates should be regulated and equipment lanes should be seeded because of the hazard of erosion.

This soil is fairly well suited to pasture. Droughtiness is the major management concern. Incorporating animal manure and green manure crops into the surface layer conserves moisture.

If this soil is used as woodland, the major management concern is plant competition. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is poorly suited to building site development because of the wetness. Buildings with basements should be constructed on well compacted fill material, which raises the site. A drainage system reduces the wetness. The soil is poorly suited to septic tank absorption fields. The wetness and a poor filtering capacity are the main limitations. Special construction methods, such as filling or mounding with suitable soil material, may be needed to raise the absorption field above the water table. The soil readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in pollution of the ground water.

The land capability classification is IVs, the woodland ordination symbol is 3A, and the Michigan soil management group is 5b.

38—Napoleon muck. This nearly level, very poorly drained soil is in closed, deep depressions. It is frequently ponded. When the water table is below the surface, the higher interior parts of the depressions are surrounded by water. Individual areas are irregularly shaped or circular and range from 3 to 100 acres in size.

Typically, the surface layer is black muck about 8 inches thick. Below this to a depth of about 60 inches is dark brown and dark reddish brown mucky peat. In places the surface layer consists of sphagnum moss 2 to 6 inches thick.

Included with this soil in mapping are small areas that are muck to a depth of less than 51 inches and are underlain by sand. These soils are in landscape

Figure 8.—A wooded area of Napoleon muck in a former kettle lake.

positions similar to those of the Napoleon soil. They make up about 6 percent of the unit.

Permeability is moderate or moderately rapid in the Napoleon soil, and the available water capacity is high. Surface runoff is very slow or ponded. The seasonal high water table is near or above the surface from September through June.

Most areas are wooded (fig. 8). In some areas wild blueberries are abundant and are harvested every other year. This soil is unsuited to most of the crops commonly grown in the county. Such crops as blueberries can be grown if the soil is adequately drained.

This soil is generally unsuited to pasture because of the ponding. Overcoming this hazard is difficult because drainage outlets are not readily available.

If this soil is used as woodland, the main management concerns are the equipment limitation, the windthrow hazard, seedling mortality, and plant competition. Equipment should be used only when the ground is frozen. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard. After trees are cut, plant competition can prevent or delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control undesirable plants. Because of a high seedling mortality rate, plant competition, and low productivity, trees generally are not planted on this soil.

Because of the ponding and excess humus, this soil is generally unsuited to building site development and septic tank absorption fields.

The land capability classification is Vlw, the woodland ordination symbol is 2W, and the Michigan soil management group is Mc-a.

39—Cohoctah loam. This nearly level, very poorly drained soil is on flood plains along rivers and creeks. It

is frequently flooded. Individual areas are elongated and range from 5 to 65 acres in size.

Typically, the surface layer is black loam about 11 inches thick. The substratum extends to a depth of about 60 inches. It is mottled. In sequence downward, it is dark gray fine sandy loam, light brownish gray fine sandy loam, pale brown sand, and grayish brown and light brownish gray fine sand. In places the surface layer is mucky loam or sandy loam.

Included with this soil in mapping are small areas of hilly or steep soils bordering the uplands. Also included are very poorly drained soils in landscape positions similar to those of the Cohoctah soil. These soils have more clay below the surface layer than the Cohoctah soil. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderately rapid in the Cohoctah soil, and the available water capacity is moderate. Surface runoff is very slow or ponded. The seasonal high water table is at or near the surface from September through May.

Most of the acreage is idle land. Some areas are wooded or are used as cropland.

Because of the wetness and the frequent flooding, this soil is generally unsuited to cropland. Draining the soil is difficult because the water table is often near the water level in the adjacent rivers and creeks.

This soil is poorly suited to pasture. Water pollution can occur unless access of livestock to streams and rivers is restricted and runoff is diverted.

If this soil is used as woodland, the major management concerns are the equipment limitation, the windthrow hazard, seedling mortality, and plant competition. Equipment should be used only when the soil is frozen or relatively dry. Because of the seasonal high water table, trees on this soil are shallow rooted and can be blown down during periods of high wind. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard. Because of the wetness and the hazard of flooding, trees generally are not planted on this soil.

This soil is not suited to building site development or septic tank absorption fields because of the hazard of flooding.

The land capability classification is Vw, the woodland ordination symbol is 2W, and the Michigan soil management group is L-2c.

40B—Coloma loamy sand, 0 to 6 percent slopes. This nearly level and undulating, somewhat excessively drained soil is on knolls and small ridges in the uplands. Individual areas are irregularly shaped and range from 3 to 100 acres in size.

Typically, the surface layer is dark brown loamy sand about 10 inches thick. The subsurface layer is yellowish brown and brownish yellow, loose sand about 24 inches thick. Below this to a depth of about 60 inches is light yellowish brown, loose sand that has thin bands of dark brown loamy sand. In some areas the soil does not have bands. In other areas the total thickness of the bands is more than 6 inches. In places the surface layer is sand or loamy fine sand.

Permeability is rapid, and the available water capacity is low. Surface runoff is slow.

Most areas are farmed. Some are used as woodland.

This soil is poorly suited to cropland, but such crops as corn, small grain, soybeans, and alfalfa hay and specialty crops, such as cherries, asparagus, and strawberries, can be grown. The main management needs are measures that maintain the supply of soil moisture and the content of organic matter and help to control soil blowing. Examples are establishing field windbreaks, growing cover crops, wind stripcropping, returning crop residue to the soil, and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface. Irrigation can increase crop yields if the soil moisture level is low. If the soil is irrigated, water application rates should be regulated and equipment lanes should be seeded because of the hazard of erosion.

This soil is fairly well suited to pasture. Droughtiness is the main management concern. Incorporating animal manure and green manure crops into the surface layer conserves moisture. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

If this soil is used as woodland, the major management concerns are the equipment limitation and seedling mortality. Loose sand can interfere with the traction of wheeled equipment during dry periods. Logging roads should be stabilized. The seedling survival rate can be increased by applying special site preparation methods, such as furrowing, and by selecting container-grown nursery stock for planting.

This soil is well suited to building site development. It is suited to septic tank absorption fields, but it has a poor filtering capacity. It readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in pollution of the ground water.

The land capability classification is IVs, the woodland ordination symbol is 2S, and the Michigan soil management group is 4a.

40C—Coloma loamy sand, 6 to 12 percent slopes. This gently rolling, somewhat excessively drained soil is on ridges and the sides of knolls in the uplands.

Individual areas are irregularly shaped and range from 10 to 30 acres in size.

Typically, the surface layer is dark brown loamy sand about 10 inches thick. The subsurface layer is yellowish brown and brownish yellow, loose sand about 24 inches thick. Below this to a depth of about 60 inches is light brownish yellow, loose sand that has thin bands of dark brown loamy sand. In some places the soil does not have bands. In other places the total thickness of the bands is more than 6 inches. In some areas the surface layer is sand or loamy fine sand.

Permeability is rapid, and the available water capacity is low. Surface runoff is medium.

Most areas are wooded. Some of the acreage is in pasture or is idle land.

This soil is generally unsuited to crops because of droughtiness, soil blowing, and the hazard of water erosion. In some areas, however, small grains are planted in order to establish a hay crop.

This soil is fairly well suited to pasture. The major management concerns are droughtiness and water erosion. Incorporating animal manure and green manure crops into the surface layer increases the moisture supply. Overgrazing during dry periods can destroy the plant cover. Rotation grazing and deferment of grazing during dry periods help to maintain the plant cover and thus reduce the susceptibility to erosion.

If this soil is used as woodland, the major management concerns are the equipment limitation and seedling mortality. Loose sand can interfere with the traction of wheeled equipment during dry periods. Logging roads should be stabilized. The seedling survival rate can be increased by applying special site preparation methods, such as furrowing, and by selecting container-grown nursery stock for planting.

This soil is fairly well suited to building site development and septic tank absorption fields. The slope is the main limitation. Buildings should be designed so that they conform to the natural slope of the land. Land shaping and installing the distribution lines across the slope help to ensure that septic tank absorption fields function properly. The soil readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in pollution of the ground water.

The land capability classification is VIs, the woodland ordination symbol is 2S, and the Michigan soil management group is 4a.

41B—Spinks-Oshtemo complex, 2 to 6 percent slopes. These undulating, well drained soils are on low knolls and ridges and on some broad plains in the uplands. Individual areas are irregularly shaped and range from 15 to 100 acres in size. They are about 65 to 75 percent Spinks soil and 25 to 35 percent Oshtemo soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Spinks soil has a surface layer of dark brown loamy sand about 10 inches thick. The subsurface layer is yellowish brown, very friable loamy fine sand about 8 inches thick. The next 35 inches is yellowish brown and dark yellowish brown, very friable loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is brown sand. In some places the total thickness of the bands in the soil is less than 6 inches. In other places the lower part of the soil has more clay. In some areas the surface layer is fine sand.

Typically, the Oshtemo soil has a surface layer of dark brown sandy loam about 11 inches thick. The subsoil is about 31 inches thick. The upper part is brown and dark brown, friable sandy loam. The lower part is strong brown, very friable loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand that has dark brown bands of sandy loam. In some places the subsoil has more clay. In other places the surface layer is loamy sand.

Permeability is moderately rapid or rapid in the Spinks soil and moderately rapid in the Oshtemo soil. The available water capacity is low in the Spinks soil and moderate in the Oshtemo soil. Surface runoff is slow on both soils.

Most areas are used as cropland. Some are used as woodland.

These soils are fairly well suited to such crops as corn, soybeans, winter wheat, and alfalfa hay. The main management needs are measures that maintain the supply of soil moisture and the content of organic matter and help to control soil blowing. Examples are establishing field windbreaks, growing cover crops, wind stripcropping, returning crop residue to the soil, and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface. Irrigation can increase crop yields if the soil moisture level is low. If the soils are irrigated, water application rates should be regulated and equipment lanes should be seeded because of the hazard of erosion.

These soils are fairly well suited to pasture. Droughtiness is the major management concern. Incorporating animal manure and green manure crops into the surface layer conserves moisture. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

If these soils are used as woodland, the major management concern is plant competition. When

openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

These soils are well suited to building site development and septic tank absorption fields.

The land capability classification is IIIs, the woodland ordination symbol is 4A, and the Michigan soil management groups are 4a and 3a.

41C—Spinks-Oshtemo complex, 6 to 12 percent slopes. These gently rolling, well drained soils are on knolls and ridges in the uplands. Individual areas are irregularly shaped and range from 7 to 240 acres in size. They are about 65 to 75 percent Spinks soil and 25 to 35 percent Oshtemo soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Spinks soil has a surface layer of dark brown loamy sand about 10 inches thick. The subsurface layer is yellowish brown, very friable loamy fine sand about 8 inches thick. The next 35 inches is yellowish brown and dark yellowish brown, very friable loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is brown sand. In some places the total thickness of the bands is less than 6 inches. In other places the lower part of the soil has more clay. In some areas the surface layer is fine sand.

Typically, the Oshtemo soil has a surface layer of dark brown sandy loam about 11 inches thick. The subsoil is about 31 inches thick. The upper part is brown and dark brown, friable sandy loam. The lower part is strong brown, very friable loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand that has dark brown bands of sandy loam. In some places the subsoil has more clay. In other places the surface layer is loamy sand.

Included with these soils in mapping are areas of well drained soils that have a slope of 12 to 18 percent and areas of soils that have a slope of less than 6 percent. Included soils make up about 6 percent of the unit.

Permeability is moderately rapid or rapid in the Spinks soil and moderately rapid in the Oshtemo soil. The available water capacity is low in the Spinks soil and moderate in the Oshtemo soil. Surface runoff is slow on the Spinks soil and medium on the Oshtemo soil.

Most areas are used as woodland. Some are used as cropland.

These soils are fairly well suited to such crops as corn, soybeans, winter wheat, and alfalfa hay. The main management needs are measures that help to control water erosion and soil blowing and maintain the supply of soil moisture and the content of organic matter. Examples are establishing field windbreaks, growing cover crops, returning crop residue to the soil, and applying a system of conservation tillage that does not invert the soil and that leaves all or part of the residue on the surface. Irrigation can increase crop yields if the soil moisture level is low. If the soils are irrigated, water application rates should be regulated and equipment lanes should be seeded because of the hazard of erosion.

These soils are well suited to pasture (fig. 9). The major management concerns are droughtiness and the hazard of erosion. Incorporating animal manure into the surface layer conserves moisture. During the summer months when the soil moisture level is low, overgrazing can reduce the extent of the plant cover and thus increase the susceptibility to erosion. Proper stocking rates, controlled grazing, and restricted use during dry periods help to maintain a good plant cover and thus help to control erosion.

The main concern in managing woodland is plant competition. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

These soils are fairly well suited to building site development and septic tank absorption fields. The slope is the main limitation. Buildings should be designed so that they conform to the natural slope of the land. Land shaping and installing the distribution lines across the slope help to ensure that septic tank absorption fields function properly.

The land capability classification is IIIe, the woodland ordination symbol is 4A, and the Michigan soil management groups are 4a and 3a.

41D—Spinks-Oshtemo complex, 12 to 18 percent slopes. These hilly, well drained soils are on convex ridgetops and on knolls and side slopes in the uplands. Individual areas are irregularly shaped and range from 5 to 180 acres in size. They are 65 to 75 percent Spinks soil and 25 to 35 percent Oshtemo soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Spinks soil has a surface layer of dark brown loamy sand about 10 inches thick. The subsurface layer is yellowish brown, very friable loamy fine sand about 8 inches thick. The next 35 inches is yellowish brown and dark yellowish brown, very friable loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is brown sand. In some places the total thickness of the bands is less than 6 inches. In other places the lower part of the

Figure 9.—A pasture in an area of the Spinks-Oshtemo complex, 6 to 12 percent slopes.

soil has more clay. In some areas the surface layer is fine sand.

Typically, the Oshtemo soil has a surface layer of dark brown sandy loam about 6 inches thick. The subsoil is about 36 inches thick. The upper part is brown and dark brown, friable sandy loam. The lower part is yellowish brown, very friable loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand that has dark brown bands of sandy loam. In some places the subsoil has more clay. In other places the surface layer is loamy sand.

Included with these soils in mapping are areas of well drained soils that have a slope of 6 to 12 percent. These included soils make up about 15 percent of the unit.

Permeability is moderately rapid or rapid in the Spinks soil and moderately rapid in the Oshtemo soil. The available water capacity is low in the Spinks soil and moderate in the Oshtemo soil. Surface runoff is medium on the Spinks soil and rapid on the Oshtemo soil.

Most areas are wooded. A few are used as pasture.

These soils are poorly suited to corn and soybeans, but such crops as winter wheat and alfalfa hay can be grown. Water erosion, soil blowing, and droughtiness are the main management concerns. A system of conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface can help to prevent excessive soil loss. Crop rotations that include hay and small grain also help to prevent excessive soil loss. Returning crop residue to the soil and regularly adding other organic material improve fertility, maintain soil structure, and increase the available water capacity.

These soils are fairly well suited to pasture. The major management concerns are water erosion and droughtiness. Pasture rotation, deferment of grazing during dry periods, and strip grazing help to control erosion and maintain the plant cover. An adequate plant

cover reduces the runoff rate and increases the rate of water infiltration.

The main concern in managing woodland is plant competition. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

These soils are poorly suited to building site development and septic tank absorption fields. The slope is the main limitation. Buildings should be designed so that they conform to the natural slope of the land. Land shaping is necessary in most areas. The distribution lines in septic tank absorption fields should be installed on the contour.

The land capability classification is IVe, the woodland ordination symbol is 4A, and the Michigan soil management groups are 3a and 5a.

41E—Spinks-Oshtemo complex, 18 to 35 percent slopes. These steep, well drained soils are on side slopes and ridges in the uplands. Individual areas are irregularly shaped and range from 5 to 75 acres in size. They are about 40 to 60 percent Spinks soil and 25 to 35 percent Oshtemo soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Spinks soil has a surface layer of dark brown loamy sand about 10 inches thick. The subsurface layer is yellowish brown, very friable loamy fine sand about 8 inches thick. The next 35 inches is yellowish brown and dark yellowish brown, very friable loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is brown sand. In some places the total thickness of the bands is less than 6 inches. In other places the lower part of the soil has more clay. In some areas the surface layer is fine sand.

Typically, the Oshtemo soil has a surface layer of dark brown sandy loam about 11 inches thick. The subsoil is about 31 inches thick. The upper part is brown and dark brown, friable sandy loam. The lower part is yellowish brown, very friable loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand that has dark brown bands of sandy loam. In some places the subsoil has more clay. In other places the surface layer is loamy sand.

Included with these soils in mapping are small areas of soils that have a slope of 6 to 18 percent. These included soils make up 10 to 15 percent of the unit.

Permeability is moderately rapid or rapid in the Spinks soil and moderately rapid in the Oshtemo soil. The available water capacity is low in the Spinks soil and moderate in the Oshtemo soil. Surface runoff is medium on the Spinks soil and rapid on the Oshtemo soil.

Most areas are used as woodland. A few are pastured.

Because of the slope and droughtiness, these soils are generally unsuitable as cropland. They are poorly suited to pasture. The major concerns in managing pastured areas are the erosion hazard and the droughtiness. Pasture rotation and restricted use during dry periods help to maintain a good plant cover and thus help to control erosion. An adequate plant cover reduces the runoff rate and increases the rate of water infiltration, thus lessening the droughtiness.

The main concerns in managing woodland are the equipment limitation, the erosion hazard, seedling mortality, and plant competition. Because of the erosion hazard, logging roads should be built on the contour and water should be removed by water bars, outsloping road surfaces, culverts, and drop structures. Landings and skid roads should be seeded after the trees are logged. Selecting container-grown nursery stock for planting reduces the seedling mortality rate. Plant competition can be controlled by mechanical or chemical means.

These soils are generally unsuited to building site development and septic tank absorption fields because of the slope.

The land capability classification is VIIe, the woodland ordination symbol is 4R, and the Michigan soil management groups are 3a and 4a.

42—Udipsamments and Udorthents, nearly level. These soils are in areas where the landscape has been altered by cutting and filling. In some places the original surface layer and part of the subsoil have been removed. In other places the lower, wetter, debris-filled depressions have been filled or covered with sandy or loamy soil material.

These soils are used mainly for recreational, industrial, and residential development. Some of the acreage is idle land. Onsite investigation is needed to determine the suitability for specific uses.

These soils are not assigned to interpretive groups.

44B—Urban land-Spinks complex, 0 to 6 percent slopes. This map unit consists of Urban land and a nearly level and undulating, well drained Spinks soil. The unit is on flats, small ridges, and knolls. Individual areas are irregularly shaped and range from 35 to 250 acres in size. They are about 40 to 60 percent Urban land and 25 to 35 percent Spinks soil. The Urban land and Spinks soil occur as areas so intricately mixed or so small that separating them in mapping was not practical.

The Urban land is covered by streets, parking lots, buildings, and other structures that so obscure or alter the soils that identification of the soil series is not feasible.

Typically, the surface layer of the Spinks soil is dark brown loamy sand about 10 inches thick. The subsurface layer is yellowish brown, very friable loamy fine sand about 8 inches thick. The next 35 inches is yellowish brown and dark yellowish brown, very friable loamy sand that has dark brown bands of sandy loam. The substratum to a depth of about 60 inches is brown sand. In some places the total thickness of the bands is less than 6 inches. In other places the lower part of the soil has more clay.

Included in this unit in mapping are small areas of the well drained Oshtemo soils. These soils are less droughty than the Spinks soil. They are in landscape positions similar to those of the Spinks soil. They make up about 5 percent of the unit.

Permeability is moderately rapid or rapid in the Spinks soil, and the available water capacity is low. Surface runoff is slow.

The Spinks soil generally is used for gardens, borrow areas, lawns, or building site development. Some of the acreage is idle land.

In the areas where the Spinks soil is used for gardens, the major management concerns are droughtiness and soil blowing. The perennial plants that can withstand the droughtiness grow better than other plants. A plant cover and mulch can help to control soil blowing.

The Spinks soil is well suited to building site development. Sanitary facilities should be connected to a central sewer system or treatment facility.

This map unit is not assigned to interpretive groups.

45B—Urban land-Kalamazoo complex, 0 to 6 percent slopes. This map unit consists of Urban land and a nearly level and undulating, well drained Kalamazoo soil. The unit is on flats, small ridges, and knolls. Individual areas are irregularly shaped and range from 20 to 300 acres in size. They are about 65 to 75 percent Urban land and 25 to 35 percent Kalamazoo soil. The Urban land and Kalamazoo soil occur as areas so intricately mixed or so small that separating them in mapping was not practical.

The Urban land is covered by streets, parking lots, buildings, and other structures that so obscure or alter the soils that identification of the soil series is not feasible.

Typically, the Kalamazoo soil has a surface layer of dark grayish brown loam about 9 inches thick. The subsoil is about 33 inches thick. In sequence downward, it is dark brown, firm clay loam; strong brown, friable sandy clay loam; dark brown, friable and very friable gravelly sandy clay loam and sandy loam; and dark brown, very friable loamy sand. The substratum to a depth of about 60 inches is dark brown gravelly sand and dark yellowish brown sand. In some places the subsoil has less clay. In other places the surface layer is sandy loam.

Permeability is moderate in the upper part of the Kalamazoo soil and rapid in the lower part. The available water capacity is moderate. Surface runoff is slow.

The Kalamazoo soil generally is used for gardens, lawns, or building site development. Some of the acreage is idle land. This soil is well suited to building site development. Sanitary facilities should be connected to a central sewer system or treatment facility.

This map unit is not assigned to interpretive groups.

46B—Cassopolis fine sandy loam, 3 to 6 percent slopes. This undulating, moderately well drained soil is on ridges and in broad areas on uplands. Individual areas are irregularly shaped and range from 5 to 400 acres in size.

Typically, the surface layer is very dark grayish brown fine sandy loam about 8 inches thick. The next 3 inches is brown and dark brown, friable fine sandy loam and loam. The subsoil extends to a depth of about 65 inches. It is dark yellowish brown and firm. The upper part is clay loam, the next part is mottled sandy clay loam, and the lower part is mottled loam. In some places the subsoil has slightly less clay. In other places the surface layer is sandy loam or loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Teasdale soils. These soils are in low areas and drainageways. Also included are small areas of the well drained Riddles soils in the slightly higher landscape positions. Included soils make up about 7 percent of the unit.

Permeability is moderate in the Cassopolis soil, and the available water capacity is high. Surface runoff is medium. The seasonal high water table is at a depth of 2.5 to 6.0 feet from January through April.

Most areas are used as cropland. Some are used as pasture or woodland.

This soil is well suited to such crops as corn, soybeans, winter wheat, and alfalfa hay. The major management concern is water erosion. Returning crop residue to the soil and planting cover crops help to prevent excessive soil loss.

This soil is well suited to pasture. The main concern in managing pastured areas is the erosion hazard. Grazing after heavy rains can result in surface compaction and excessive erosion. Rotation grazing

and deferment of grazing during wet periods help to keep the pasture in good condition and reduce the hazard of erosion.

If this soil is used as woodland, the main management concern is plant competition. When openings are made in the canopy, invading plants can prevent or delay regeneration. Plant competition can be controlled by mechanical or chemical means.

This soil is fairly well suited to building site development and septic tank absorption fields. The shrink-swell potential is a limitation on sites for buildings. Replacing the upper layers of the soil with suitable material helps to overcome this limitation. The moderate permeability is a limitation on sites for septic tank absorption fields. It can be overcome by enlarging the absorption field.

The land capability classification is IIe, the woodland ordination symbol is 5A, and the Michigan soil management group is 2.5a.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 125,000 acres in the county, or 39 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county, but most are in associations 3 and 4, which are described under the heading "General Soil Map Units."

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the county that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table and all soils that are frequently flooded during the growing season qualify for prime farmland only in areas where these limitations have been overcome by drainage measures or flood control. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not these limitations have been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the county. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the county. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where wetness or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Dwight L. Quisenberry, agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops best suited to the soils, including some not commonly grown in the county, are identified; the system of land capability classification used by the Soil Conservation Service is explained *(11)*; and the estimated yields of the main crops are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

In 1984, approximately 222,300 acres in Cass County was used for crops and pasture *(14)*. Of this total, about 80,000 acres was used for corn, 40,000 acres for pasture or idle grassland, 22,000 acres for soybeans, and 14,300 acres for small grain. The remaining acreage was used for other cultivated crops and for horticulture.

Hog and pig production is of major importance in the county. In 1982, it accounted for about 75.4 percent of all the livestock products sold in the county. Cass County leads the state in hog and pig production *(7)*.

Specialty crops are of commercial importance in the county. They include blueberries, strawberries, tomatoes, radishes, and orchard crops, all of which are grown on small acreages.

Cropland

Crop production in the county could be increased by applying measures that conserve soil and water and by extending the latest crop production technology to all of the cropland in the county. The paragraphs that follow describe the main concerns in managing the cropland in the county.

Water erosion is a major hazard on some of the loamy soils that have a slope of more than 3 percent. Examples are Kalamazoo, Oshtemo, and Riddles soils. Loss of the surface layer through erosion reduces the productivity of the soils. As the surface layer is eroded, nutrients and organic matter are lost and part of the subsoil is incorporated into the plow layer. The subsoil material, which dominantly has a high pH and a low natural fertility level, can restrict seed germination and

the availability of plant nutrients. Exposure of the subsoil can increase the hazard of erosion.

Water erosion can result in clogged tile drains and sedimentation in creeks and waterways. Sediment that contains fertilizer and pesticides can reduce the quality of water. Controlling erosion reduces the runoff rate, increases the rate of water infiltration, and minimizes the loss of organic matter and the amount of sediment that enters waterways.

A system of conservation tillage that leaves crop residue on the surface increases the rate of water infiltration and reduces the hazards of runoff and erosion. No-till cropping systems require high levels of management. Herbicides and insecticides are used to control weeds, insects, and pests. No-till farming is especially effective in minimizing erosion on the lighter colored sloping soils in the county.

Grassed waterways are used on undulating and gently rolling soils. They help to control channel erosion on sloping soils. They also stabilize areas that are already eroded. Subsurface drains are installed beneath the waterways to remove excess internal water. Removing this water enhances the growth of plants and facilitates the use of machinery.

Soil blowing is a hazard on Kalamazoo, Oshtemo, and Spinks soils and on organic soils that are drained. It can be controlled by maintaining a cover of vegetation or mulch, alternating strips of row crops with strips of hay, leaving crop residue on the surface, and keeping the surface rough through proper tillage methods. Field windbreaks of suitable trees and shrubs planted at right angles to the prevailing wind also help to control soil blowing.

Wetness is a limitation on some of the cropland in the county. Some areas of the very poorly drained Gilford soils can be adequately drained. Other areas of these soils and areas of very poorly drained, organic soils, however, cannot be economically drained. The poorly drained and very poorly drained soils are in low areas and depressions where ponding occurs and where suitable gravity outlets are not readily available. Pumping stations can be used in some areas where a gravity outlet is not available. These soils have a low soil temperature and are subject to extended periods of frost, which hinder seed germination. In areas of the somewhat poorly drained Teasdale and Brady soils, a drainage system is needed. Tillage, seed germination, and plant growth are adversely affected unless excess water is removed from these soils.

Subsurface tile drainage systems are the primary methods of removing excess water. The spacing of tile drains should be based on the permeability of the soils. In some areas open ditches are needed as outlets for the tile drains. Small areas of wetter soils in swales are commonly included with the well drained soils in mapping. Fieldwork is delayed in some of these areas unless a drainage system is installed.

Soil fertility is naturally low in the sandy soils in the county. Additions of fertilizer on all soils should be based on the results of soil tests, on the needs of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kind and amount of fertilizer to be applied *(8)*.

Soil tilth is an important factor affecting the germination of seeds and the infiltration of water into the soil. Soils with good tilth are granular and porous. The use of machinery on wet soils results in surface compaction and crusting. Preparing a good seedbed in areas of severely eroded soils is difficult. These soils are low in moisture content and are susceptible to surface crusting, which hinders seed germination. An adequate drainage system, timely fieldwork, conservation tillage, and measures that maintain the content of organic matter improve soil structure, minimize compaction, and help to prevent crusting.

Further information about managing cropland is available at local offices of the Cooperative Extension Service and the Soil Conservation Service.

Pasture

Pasture is important in the county because outdoor farrowing of hogs and pigs is a major enterprise. The most commonly grown pasture species are alfalfa and bromegrass. Much of the permanent pasture is in areas of Kalamazoo and Oshtemo soils where erosion can be a hazard. Many other pastures are in areas of Riddles soils where soil compaction can be a problem.

Measures that prevent overgrazing help to protect the plant cover and thus reduce the hazards of runoff and erosion. Grazing when the soils are wet results in compaction and thus in poor forage production. The productivity of a pasture and its ability to protect the soil are influenced by the number of livestock in the pasture, the length of time that they graze, and the distribution of rainfall. Good pasture management includes proper stocking rates, pasture rotation, and deferred grazing.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension

agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the county, but estimated yields are not listed because the acreage of such crops is small. Local offices of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is shown in table 7. The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Also given at the end of each map unit description is a Michigan soil management group. The soils are assigned to a group according to the dominant profile texture, the natural drainage class, and the major management concerns. For soils making up a complex, the management groups are listed in the same order as the series named in the complex *(9).*

Woodland Management and Productivity

Table 8 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils

assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; *F*, a high content of rock fragments in the soil, and *L*, low strength. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, F, and L.

In table 8, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, fire lanes, and log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment or season of use is not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. The site index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic feet per acre per year, indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand. The volume was determined through the use of standard yield tables *(13)*.

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the dominant species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Table 9 gives information about operating harvesting or thinning equipment in logging areas and on skid trails, log landings, and haul roads. Limitations are given for the most limiting season and for the preferred season. The *most limiting season* in Cass County generally is spring or late fall. In some areas, however, it is a dry period in summer, when loose sand can limit trafficability on deep, well drained, sandy soils. The *preferred operating season* is the period when harvesting or thinning causes the least amount of soil damage. This period generally is when the soil is not too wet or when the ground is frozen or partly frozen or has an adequate snow cover.

In table 9, a rating of *slight* indicates that the use of conventional logging equipment is not restricted if normal logging methods are used. A rating of *moderate* indicates that the use of equipment is restricted because of one or more soil factors. If wetness is a limitation, high flotation equipment or special procedures may be needed to prevent the formation of ruts. A rating of *severe* indicates that the kind of equipment that can be used is seriously restricted.

Logging areas and skid trails include areas where some or all of the trees are being cut. Generally, equipment traffic is least intensive in the logging areas. Skid trails, which generally are within the logging area, are roads or trails over which logs are dragged or hauled from the stump to a log landing.

Log landings are areas where logs are assembled for transportation. Wheeled equipment may be used more frequently in these areas than in any other areas affected by logging.

Haul roads are access roads leading from primary or surfaced roads to the logging areas. The logging roads serve as transportation routes for wheeled logging equipment and logging trucks. Generally, they are unpaved roads. Some are graveled.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 10 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 10 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

The soils of the county are rated in table 11 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 11, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 11 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 14 and interpretations for dwellings without basements and for local roads and streets in table 13.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to

heavy foot traffic and some vehicular traffic. The best soils have gentle slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 12, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, rye, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian olive, autumn olive, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness.

Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. Wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail rabbit, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include ruffed grouse, woodcock, thrushes, woodpeckers, fox, squirrels, raccoon, and white-tailed deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreation uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 13 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and

landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. The depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 14 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 14 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less

than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 14 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 14 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 15 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration.

The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 15, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is as much as 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are naturally fertile or respond well to fertilizer and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel or stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel or stones, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 16 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against

overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, such toxic substances as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

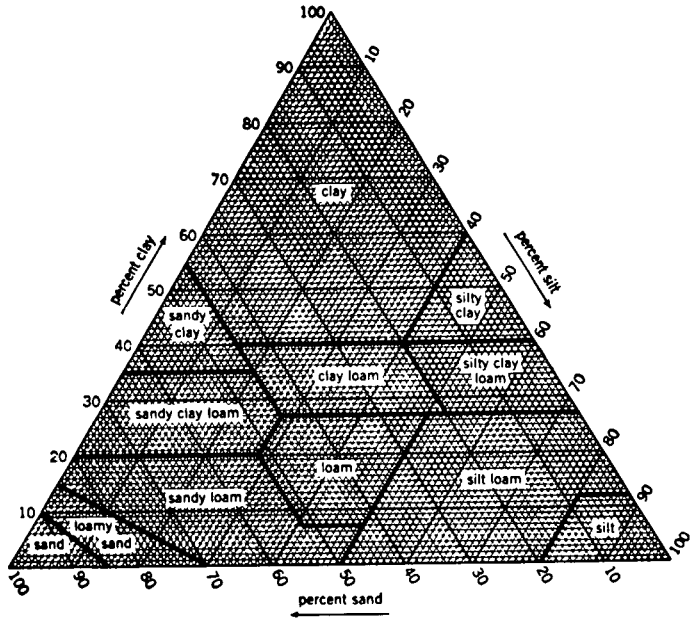

Figure 10.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 17 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 10). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to

those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the county and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the county or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 18 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated content of clay of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓ bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for

fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.
5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.
6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 18, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 19 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist

mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 19, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 19 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 19 are the depth to the seasonal high water table, the kind of water table, and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 19. An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 19 shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or

weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Characterization Data for Selected Soils

Some of the soils in Cass County were sampled for physical and chemical analyses by the Soil Research Laboratory, Ford Forestry Center, Michigan Technological University, L'Anse, Michigan. The laboratory data obtained from the soil samples include analyses of particle-size distribution, coarse fragments, bulk density, and moisture retention. Complete chemical analyses were also performed on each sample, and spodic horizon criteria were determined on the appropriate samples. Standard National Cooperative Soil Survey procedures were used for all analyses. Forest sites also were sampled for an estimate of the productivity of many of the soils for wood products.

These data were used in classifying and correlating the soils and in evaluating their behavior, especially under forestry uses. The series selected and their laboratory identification numbers are as follows: Coloma (S85MI-027-001), Kalamazoo (S8MI-027-002), and Oshtemo (S85MI-027-003).

In addition to the Cass County data, soil characterization data and forest site data are available from nearby counties having many of the same soils that were not sampled in Cass County. These data and the Cass County data are available at the Soil Research Laboratory, Ford Forestry Center, Michigan Technological University, in L'Anse, Michigan; the Environmental Division, Michigan Department of Agriculture, in Lansing, Michigan; and the State Office of the Soil Conservation Service in East Lansing, Michigan.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(12)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 20 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Alfisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udalf (*Ud*, meaning humid, plus *alf*, from Alfisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Hapludalfs (*Hapl*, meaning minimal horizonation, plus *udalf*, the suborder of the Alfisols that has a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Hapludalfs.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Hapludalfs.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (10)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (12)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Adrian Series

The Adrian series consists of very poorly drained soils in old glacial lakebeds and on flood plains. These soils formed in deposits of organic material 16 to 50

inches deep over sandy deposits. Permeability is moderately slow to moderately rapid in the organic material and rapid in the sandy material. Slopes range from 0 to 2 percent.

Typical pedon of Adrian muck, 924 feet south and 264 feet east of the northwest corner of sec. 26, T. 5 S., R. 16 W.

Oa1—0 to 9 inches; muck, black (10YR 2/1) broken face and rubbed; about 10 percent fibers, less than 5 percent rubbed; moderate medium subangular blocky structure parting to weak fine granular; very friable; mainly herbaceous fibers; medium acid; clear smooth boundary.

Oa2—9 to 20 inches; muck, black (10YR 2/1) broken face and rubbed; about 15 percent fibers, less than 5 percent rubbed; strong medium subangular blocky structure; friable; mainly herbaceous fibers; slightly acid; abrupt smooth boundary.

C1—20 to 40 inches; light olive brown (2.5Y 5/4) fine sand; few medium prominent strong brown (7.5YR 4/6) mottles and black (10YR 2/1) organic stains; single grained; loose; few fine roots; mildly alkaline; slight effervescence; clear smooth boundary.

C2—40 to 55 inches; brown (10YR 4/3) sand; common medium prominent strong brown (7.5YR 4/6) mottles and few medium prominent black (10YR 2/1) organic stains; single grained; loose; about 10 percent gravel; mildly alkaline; slight effervescence; clear smooth boundary.

C3—55 to 60 inches; light olive brown (2.5Y 5/4) sand; few medium prominent strong brown (7.5YR 4/6) mottles and black (10YR 2/1) organic stains; single grained; loose; about 2 percent gravel; strong effervescence; moderately alkaline.

The surface tier has hue of 10YR or 7.5YR, value of 2, and chroma of 1 to 3, or it is neutral in hue and has value of 2. The subsurface tier has hue of 10YR, 7.5YR, or 5YR, value of 2 or 3, and chroma of 1 or 2, or it is neutral in hue and has value of 2 or 3.

The C horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 to 4. It is fine sand, loamy sand, sand, or gravelly sand.

Barry Series

The Barry series consists of poorly drained, moderately permeable soils on till plains and moraines. These soils formed in loamy deposits. Slopes range from 0 to 2 percent.

Typical pedon of Barry loam, 95 feet east and 560 feet north of the southwest corner of sec. 27, T. 7 S., R. 14 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, gray (10YR 5/1) dry; moderate medium granular structure; friable; many fine and medium roots; slightly acid; abrupt smooth boundary.

Btg1—8 to 15 inches; very dark gray (10YR 3/1) silt loam; few fine faint dark gray (10YR 4/1) and common medium prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; few distinct very dark grayish brown (10YR 3/2) clay films on faces of peds; many fine and medium roots; slightly acid; gradual smooth boundary.

Btg2—15 to 21 inches; gray (10YR 5/1) clay loam; few medium prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; few distinct very dark grayish brown (10YR 3/1) clay films on faces of peds; common fine and medium roots; medium acid; gradual smooth boundary.

Btg3—21 to 26 inches; gray (10YR 5/1) sandy clay loam; common medium faint dark gray (10YR 4/1) and few medium prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; few distinct very dark grayish brown (10YR 3/1) clay films on faces of peds; few fine and medium roots; medium acid; gradual smooth boundary.

Bg—26 to 40 inches; gray (10YR 6/1) sandy loam; common medium faint light brownish gray (10YR 6/2) and common medium prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; few medium roots; medium acid; gradual smooth boundary.

C—40 to 60 inches; brown (10YR 5/3) sandy loam that has strata of loamy sand and sandy clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; medium acid.

The thickness of the solum ranges from 24 to 50 inches. The content of coarse fragments ranges from 0 to 10 percent throughout the profile.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. The Btg horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 or 2. It is clay loam, sandy clay loam, loam, sandy loam, or silt loam. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 1 to 4. It is sandy loam or loamy sand.

Brady Series

The Brady series consists of somewhat poorly drained, moderately rapidly permeable soils on outwash plains and lake plains. These soils formed in loamy and

sandy deposits over sandy material. Slopes range from 0 to 2 percent.

The Brady soils in this county have a darker surface layer than is defined as the range for the series. This difference, however, does not affect the use or behavior of the soils.

Typical pedon of Brady sandy loam, 0 to 2 percent slopes, 600 feet north and 594 feet east of the southwest corner of sec. 5, T. 8 S., R. 16 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; very friable; many fine roots; slightly acid; abrupt smooth boundary.

E—9 to 15 inches; brown (10YR 5/3) sandy loam; few medium prominent strong brown (7.5YR 4/6) mottles; weak medium subangular blocky structure; friable; common fine roots; slightly acid; clear smooth boundary.

Bt1—15 to 18 inches; yellowish brown (10YR 5/4) sandy loam; common medium distinct light brownish gray (10YR 6/2) and few fine prominent strong brown (7.5YR 4/6) mottles; weak medium subangular blocky structure; friable; few fine roots; common thin clay bridges between sand grains; medium acid; gradual wavy boundary.

Bt2—18 to 29 inches; brown (10YR 5/3) sandy loam; many coarse faint grayish brown (10YR 5/2) and common medium prominent strong brown (7.5YR 4/6) mottles; moderate medium subangular blocky structure; friable; few fine roots; few thin clay bridges between sand grains; medium acid; clear smooth boundary.

BC—29 to 48 inches; yellowish brown (10YR 5/4) loamy sand; many coarse prominent strong brown (7.5YR 4/6) and few fine distinct grayish brown (10YR 5/2) mottles; weak medium granular structure; very friable; neutral; gradual smooth boundary.

2C—48 to 60 inches; yellowish brown (10YR 5/4) sand; many coarse prominent strong brown (7.5YR 4/6) and common coarse distinct grayish brown (10YR 5/2) mottles; single grained; loose; neutral.

The solum ranges from 40 to 60 inches in thickness. The content of coarse fragments ranges from 0 to 20 percent throughout the profile.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. The Bt horizon has value of 4 to 6 and chroma of 3 or 4. It is sandy loam, gravelly sandy loam, or gravelly sandy clay loam. The BC horizon has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 3 to 6. It is loamy sand or sandy loam. The C horizon has chroma of 2 to 6. It is sand or gravelly sand.

Brems Series

The Brems series consists of moderately well drained, rapidly permeable soils on outwash plains. These soils formed in sandy material. Slopes range from 0 to 6 percent.

Typical pedon of Brems loamy sand, 0 to 6 percent slopes, 780 feet south and 120 feet west of the center of sec. 28, T. 8 S., R. 16 W.

Ap—0 to 9 inches; dark brown (10YR 3/3) loamy sand, brown (10YR 5/3) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

Bw1—9 to 23 inches; yellowish brown (10YR 5/6) loamy sand; weak fine granular structure; very friable; slightly acid; clear smooth boundary.

Bw2—23 to 51 inches; strong brown (7.5YR 5/6) sand; many coarse prominent light brownish gray (10YR 6/2) and few fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; strongly acid; gradual wavy boundary.

C—51 to 60 inches; very pale brown (10YR 7/3) fine sand; few fine faint light brownish gray (10YR 6/2) and few fine prominent yellowish brown (10YR 5/6) mottles; single grained; loose; strongly acid.

The solum ranges from 35 to more than 60 inches in thickness. The content of coarse fragments ranges from 0 to 5 percent throughout the profile.

The Ap horizon has value of 3 to 5 and chroma of 2 to 4. The Bw and C horizons are fine sand, sand, or loamy sand. The Bw horizon has value and chroma of 4 to 6. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 2 to 6.

Bronson Series

The Bronson series consists of moderately well drained, moderately rapidly permeable soils on outwash plains. These soils formed in loamy and sandy material. Slopes range from 0 to 3 percent.

The Bronson soils in this county have a darker surface layer than is defined as the range for the series. This difference, however, does not affect the use or behavior of the soils.

Typical pedon of Bronson loamy sand, 0 to 3 percent slopes, 1,128 feet north and 1,190 feet west of the center of sec. 35, T. 5 S., R. 16 W.

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) loamy sand, brown (10YR 5/3) dry; moderate medium granular structure; very friable; many fine roots; neutral; abrupt smooth boundary.

E—10 to 18 inches; brown (10YR 4/3) loamy sand; weak medium granular structure; very friable; many

fine roots; about 3 percent gravel; neutral; abrupt wavy boundary.

Bt1—18 to 24 inches; dark yellowish brown (10YR 4/4) sandy loam; weak medium subangular blocky structure; friable; few distinct brown (10YR 4/3) clay films on faces of peds; about 5 percent gravel; medium acid; clear wavy boundary.

Bt2—24 to 42 inches; brown (10YR 4/3) sandy loam; common medium faint grayish brown (10YR 5/2) and common medium prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; few distinct dark yellowish brown (10YR 4/4) clay films on faces of peds; about 8 percent gravel; strongly acid; gradual smooth boundary.

Bt3—42 to 47 inches; dark brown (7.5YR 4/4) sandy loam; common medium prominent grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; few distinct dark brown (7.5YR 3/2) clay films on faces of peds; about 8 percent gravel; strongly acid; clear smooth boundary.

2BC—47 to 62 inches; dark yellowish brown (10YR 4/6) loamy sand; nodules and thin bands of strong brown (7.5YR 4/6) sandy loam ⅛ inch to 2 inches thick; weak fine granular structure; very friable; strongly acid.

The thickness of the solum and the depth to free carbonates range from 41 to more than 70 inches. The content of coarse fragments ranges from 0 to 10 percent throughout the solum.

The Ap horizon has chroma of 2 or 3. The E horizon has value of 5 to 7 and chroma of 2 or 3. The Bt horizon has value of 4 or 5. It is sandy loam or sandy clay loam. Some pedons have a 2C horizon. This horizon has hue of 10YR, value of 5 or 6, and chroma of 2 or 3. It is sand, coarse sand, or gravelly sand.

Cassopolis Series

The Cassopolis series consists of moderately well drained, moderately permeable soils on moraines and till plains. These soils formed in loamy material. Slopes range from 3 to 6 percent.

Typical pedon of Cassopolis fine sandy loam, 3 to 6 percent slopes, 1,100 feet north and 1,420 feet west of the center of sec. 16, T. 8 S., R. 14 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) fine sandy loam, brown (10YR 5/3) dry; weak medium granular structure; friable; many fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

E/B—8 to 11 inches; brown (10YR 5/3) fine sandy loam, grayish brown (10YR 5/2) dry (E); weak medium granular structure; friable; about 70 percent tongues extending into or completely surrounding remnants of dark brown (10YR 4/3) loam (B); moderate medium subangular blocky structure; friable; many fine roots; about 2 percent gravel; slightly acid; clear wavy boundary.

Bt1—11 to 17 inches; dark yellowish brown (10YR 4/4) clay loam; strong medium subangular blocky structure; firm; common fine roots; common distinct dark grayish brown (10YR 4/2) clay films on vertical faces of peds; about 2 percent gravel; neutral; gradual wavy boundary.

Bt2—17 to 31 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; firm; few fine roots; few distinct dark grayish brown (10YR 4/2) clay films on vertical faces of peds; about 2 percent gravel; medium acid; gradual wavy boundary.

Bt3—31 to 61 inches; dark yellowish brown (10YR 4/4) sandy clay loam; common medium distinct grayish brown (10YR 5/2) and brown (10YR 5/3) mottles; moderate medium subangular blocky structure; firm; thin discontinuous clay films on faces of peds; about 2 percent gravel; medium acid; gradual wavy boundary.

BC—61 to 65 inches; dark yellowish brown (10YR 4/4) loam; few fine faint grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; friable; about 2 percent gravel; medium acid.

The solum ranges from 40 to 80 inches in thickness. The content of coarse fragments ranges from 1 to 8 percent throughout the solum.

The Ap horizon has value of 3 or 4 and chroma of 2 or 3. The E part of the E/B horizon has value of 4 or 5 and chroma of 3 or 4. It is fine sandy loam or loam. Some pedons have a 3- or 4-inch E horizon above the E/B horizon.

The Bt part of the E/B horizon has colors and textures similar to those of the Bt horizon. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It is dominantly clay loam or sandy clay loam, but in some pedons it has subhorizons of silty clay loam or loam. The BC horizon has value and chroma of 4 or 5. It is dominantly loam, but the range includes sandy loam.

Some pedons have a C horizon. This horizon has value of 4 or 5 and chroma of 3 or 4. It is dominantly loam or sandy loam, but in some pedons it has pockets or thin strata of sand, loamy sand, or the gravelly analogs of those textures.

Cohoctah Series

The Cohoctah series consists of very poorly drained, moderately rapidly permeable soils in nearly level areas and depressions on flood plains, including shallow, abandoned drainageways. These soils formed in loamy and sandy alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Cohoctah loam, 780 feet east and 100 feet south of the northwest corner of sec. 2, T. 6 S., R. 16 W.

Ap—0 to 11 inches; black (10YR 2/1) loam, gray (10YR 5/1) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.
Cg1—11 to 15 inches; dark gray (10YR 4/1) fine sandy loam; common fine faint light brownish gray (10YR 6/2) mottles; massive; friable; black (10YR 2/1) organic lenses; neutral; abrupt smooth boundary.
Cg2—15 to 25 inches; light brownish gray (10YR 6/2) fine sandy loam; few fine prominent brownish yellow (10YR 6/6) mottles; massive; friable; very dark gray (10YR 3/1) organic stains; neutral; abrupt smooth boundary.
2C—25 to 28 inches; pale brown (10YR 6/3) sand; few fine distinct brownish yellow (10YR 6/6) mottles; massive; mildly alkaline; abrupt wavy boundary.
2Cg1—28 to 31 inches; grayish brown (10YR 5/2) fine sand; common medium distinct dark yellowish brown (10YR 4/6) mottles; massive; friable; black (10YR 2/1) organic stains; mildly alkaline; abrupt wavy boundary.
2Cg2—31 to 60 inches; light brownish gray (10YR 6/2) fine sand; few fine faint grayish brown (10YR 5/2) mottles; massive; friable; black (10YR 2/1) organic stains; mildly alkaline.

The mollic epipedon is 10 to 13 inches thick. The content of coarse fragments ranges from 0 to 5 percent in the C horizon and from 0 to 20 percent in the 2Cg horizon.

The A horizon has value of 2 or 3. The Cg horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is sandy loam, loam, fine sandy loam, or silt loam. The 2Cg horizon has colors similar to those of the Cg horizon. It is sand, fine sand, loamy fine sand, loamy sand, gravelly sand, or gravelly loamy sand.

Coloma Series

The Coloma series consists of somewhat excessively drained, rapidly permeable soils on outwash plains and moraines. These soils formed in sandy material. Slopes range from 0 to 12 percent.

Typical pedon of Coloma loamy sand, 0 to 6 percent slopes, 1,350 feet north and 620 feet east of the center of sec. 15, T. 6 S., R. 16 W.

Ap—0 to 10 inches; dark brown (10YR 3/3) loamy sand, pale brown (10YR 6/3) dry; weak medium granular structure; very friable; about 2 percent gravel; slightly acid; abrupt smooth boundary.
E1—10 to 18 inches; yellowish brown (10YR 5/6) sand; single grained; loose; about 2 percent gravel; slightly acid; gradual smooth boundary.
E2—18 to 34 inches; brownish yellow (10YR 6/6) sand; single grained; loose; about 3 percent gravel; slightly acid; abrupt wavy boundary.
E&Bt—34 to 60 inches; light yellowish brown (10YR 6/4) sand (E); single grained; loose; ¼-inch lamellae of dark brown (7.5YR 4/4) loamy sand (Bt) 4 to 8 inches apart, having a combined thickness of less than 6 inches; weak very fine subangular blocky structure; very friable; about 7 percent gravel; slightly acid.

The thickness of the solum ranges from 50 to 70 inches. The content of coarse fragments ranges from 0 to 10 percent throughout the solum.

The Ap horizon has value of 3 or 4. The E horizon has hue of 10YR or 7.5YR and value and chroma of 4 to 6. It is sand, fine sand, or loamy sand.

The E part of the E&Bt horizon has value of 5 or 6 and chroma of 4 to 6. It is loamy sand, sand, or fine sand. The B part has hue of 10YR, 7.5YR, or 5YR, value of 4 or 5, and chroma of 4 to 6. It is loamy sand or sandy loam.

Edwards Series

The Edwards series consists of very poorly drained soils in old lakebeds. These soils formed in organic material that is 16 to 50 inches deep over marl. Permeability is moderately slow to moderately rapid. Slopes range from 0 to 2 percent.

Typical pedon of Edwards muck, 1,848 feet north and 528 west of the southeast corner of sec. 15, T. 5 S., R. 16 W.

Oa1—0 to 12 inches; muck, black (10YR 2/1) broken face and rubbed; a trace of fibers; weak fine granular structure; very friable; neutral; abrupt smooth boundary.
Oa2—12 to 22 inches; muck, black (10YR 2/1) and very dark gray (10YR 3/1) broken face, very dark brown (10YR 2/2) rubbed; about 10 percent fibers, less than 1 percent rubbed; strong coarse subangular blocky structure parting to moderate medium granular; very friable; neutral; abrupt smooth boundary.

Cg—22 to 60 inches; light brownish gray (2.5Y 6/2) marl; massive; friable; strong effervescence; moderately alkaline.

Depth to the Cg horizon ranges from 16 to 50 inches. The surface tier has hue of 10YR or is neutral in hue. It has value of 2 and chroma of 0 to 2. The subsurface tier has hue of 10YR, 7.5Y, or 5YR, value of 2 to 4, and chroma of 1 or 2. The Cg horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 8, and chroma of 1 or 2. In some pedons the marl has a 1- or 2-inch layer of sandy material within a depth of 51 inches.

Elston Series

The Elston series consists of well drained, moderately rapidly permeable soils on outwash plains. These soils formed in loamy and sandy sediments. Slopes range from 0 to 6 percent.

Typical pedon of Elston sandy loam, 0 to 2 percent slopes, 680 feet west and 390 feet north of the southeast corner of sec. 13, T. 8 S., R. 16 W.

Ap—0 to 11 inches; black (10YR 2/1) sandy loam, very dark brown (10YR 2/2) dry; weak medium granular structure; very friable; many fine and medium roots; strongly acid; clear smooth boundary.

A—11 to 14 inches; black (10YR 2/1) sandy loam, very dark brown (10YR 2/2) dry; weak medium subangular blocky structure; friable; many fine and medium roots; strongly acid; abrupt smooth boundary.

Bt1—14 to 17 inches; dark yellowish brown (10YR 3/4) sandy clay loam; moderate medium subangular blocky structure; friable; few faint very dark grayish brown (10YR 3/2) clay films on faces of peds; about 4 percent gravel; common fine roots; strongly acid; abrupt smooth boundary.

Bt2—17 to 27 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine subangular blocky structure parting to weak fine granular; very friable; few faint very dark grayish brown (10YR 3/2) clay films on faces of peds; about 3 percent gravel; common fine roots; strongly acid; gradual smooth boundary.

2Bt3—27 to 41 inches; dark brown (7.5YR 4/4) loamy sand; weak fine subangular blocky structure parting to weak fine granular; very friable; few thin clay bridges between sand grains; about 4 percent gravel; few fine roots; slightly acid; gradual smooth boundary.

2C1—41 to 46 inches; strong brown (7.5YR 5/6) sand; single grained; loose; about 2 percent gravel; slightly acid; gradual smooth boundary.

2C2—46 to 60 inches; yellowish brown (10YR 5/8) sand; single grained; loose; about 8 percent gravel; neutral.

The thickness of the solum ranges from 40 to 60 inches. The content of coarse fragments ranges from 0 to 15 percent throughout the profile.

The Ap horizon has value of 2 or 3 and chroma of 1 to 3. The Bt horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 3 or 4. It is dominantly sandy loam or sandy clay loam but has subhorizons of loamy sand or loam. The 2C horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 3 to 8.

Gilford Series

The Gilford series consists of very poorly drained, moderately rapidly permeable soils on outwash plains. These soils formed in loamy and sandy material. Slopes range from 0 to 2 percent.

Typical pedon of Gilford sandy loam, 840 feet south and 105 feet west of the northeast corner of sec. 22, T. 8 S., R. 14 W.

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; neutral; clear smooth boundary.

Bg1—10 to 14 inches; light brownish gray (10YR 6/2) sandy loam; few fine faint grayish brown (10YR 5/2) and common medium prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; about 2 percent gravel; neutral; gradual smooth boundary.

Bg2—14 to 22 inches; light brownish gray (10YR 6/2) sandy loam; few fine distinct yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; friable; about 2 percent gravel; neutral; gradual smooth boundary.

2Cg—22 to 28 inches; light brownish gray (10YR 6/2) loamy sand; few fine faint pale brown (10YR 6/3) mottles; massive; friable; about 4 percent gravel; neutral; gradual wavy boundary.

2C—28 to 60 inches; brown (10YR 5/3) loamy sand; few fine faint dark yellowish brown (10YR 4/4) mottles; massive; friable; about 6 percent gravel; neutral.

The thickness of the solum ranges from 20 to 40 inches. The content of gravel ranges from 0 to 8 percent in the solum and from 0 to 12 percent in the 2C horizon.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. The Bg horizon has hue of 10YR, 7.5YR, 5Y, or 2.5Y, value of 4 to 6, and chroma of 1 or 2, or it is

neutral in hue and has value of 4 to 6. It is sandy loam or fine sandy loam. The 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 6, and chroma of 1 to 3. It is dominantly loamy sand, but the range includes sand.

Glendora Series

The Glendora series consists of very poorly drained, rapidly permeable soils on flood plains. These soils formed in sandy alluvium. Slopes range from 0 to 2 percent.

The Glendora soils in this county are taxadjuncts to the series because they have a thin organic surface layer. This difference, however, does not affect the use or behavior of the soils.

Typical pedon of Glendora muck, 660 feet south and 180 feet west of the northeast corner of sec. 19, T. 5 S., R. 15 W.

Oa—0 to 6 inches; black (5Y 2/1) muck; weak medium granular structure; very friable; many fine roots; slightly acid; abrupt smooth boundary.
A—6 to 9 inches; black (5Y 2/2) mucky fine sandy loam; massive; friable; neutral; abrupt smooth boundary.
Cg1—9 to 25 inches; light brownish gray (2.5Y 6/2) loamy fine sand; about 5 percent black (N 2/0) organic stains; massive; very friable; neutral; gradual wavy boundary.
Cg2—25 to 40 inches; grayish brown (2.5Y 5/2) sand; about 5 percent black (N 2/0) and 20 percent very dark grayish brown (2.5Y 3/2) organic stains; massive; very friable; neutral; gradual wavy boundary.
Cg3—40 to 60 inches; grayish brown (2.5Y 5/2) sand; about 30 percent black (N 2/0) organic stains; massive; very friable; neutral.

The Oa horizon has hue of 10YR to 5Y or is neutral in hue. It has chroma of 0 to 2. It ranges from 3 to 9 inches in thickness. The A horizon is dominantly mucky fine sandy loam, but the range includes mucky loam, loam, fine sandy loam, loamy fine sand, mucky loamy fine sand, loamy sand, and mucky loamy sand. The Cg horizon has hue of 2.5Y or 10YR, value of 2 to 6, and chroma of 1 or 2, or it is neutral in hue and has value of 2 to 6. It is sand, fine sand, loamy sand, or loamy fine sand. The content of gravel in this horizon is 0 to 3 percent. Some pedons have organic bands, which have hue of 10YR, value of 2 to 5, and chroma of 1 or 2.

Houghton Series

The Houghton series consists of very poorly drained soils in depressions and drainageways in old glacial lakebeds. These soils formed in more than 51 inches of herbaceous organic material. Permeability is moderately slow to moderately rapid. Slopes range from 0 to 2 percent.

Typical pedon of Houghton muck, 528 feet north and 2,574 feet east of the southwest corner of sec. 10, T. 8 S., R. 13 W.

Oa1—0 to 15 inches; black (N 2/0) muck; weak medium granular structure; very friable; slightly acid; clear smooth boundary.
Oa2—15 to 25 inches; dark reddish brown (5YR 3/2) muck; weak medium platy structure; friable; slightly acid; gradual smooth boundary.
Oa3—25 to 60 inches; dark reddish brown (5YR 2/2) muck; weak medium platy structure; friable; slightly acid.

The thickness of the organic material ranges from 51 to more than 60 inches. The organic fibers are derived primarily from herbaceous plants, but some layers contain 5 to 10 percent woody material. The organic material has hue of 10YR, 7.5YR, or 5YR, value of 2 or 3, and chroma of 1 or 2, or it is neutral in hue and has value of 2 or 3.

Kalamazoo Series

The Kalamazoo series consists of well drained soils on outwash plains. These soils formed in loamy and sandy material. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 18 percent.

Typical pedon of Kalamazoo loam, 2 to 6 percent slopes, 24 feet south and 790 feet west of the northeast corner of sec. 21, T. 7 S., R. 13 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; firm; many fine roots; medium acid; clear smooth boundary.
Bt1—9 to 20 inches; dark brown (7.5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; few distinct dark brown (7.5YR 3/4) clay films on faces of peds; common fine roots; about 2 percent gravel; slightly acid; clear wavy boundary.
Bt2—20 to 24 inches; strong brown (7.5YR 5/6) sandy clay loam; moderate medium subangular blocky structure; friable; few distinct dark brown (7.5YR 4/4) clay films on faces of peds; about 2 percent gravel; medium acid; clear wavy boundary.
Bt3—24 to 27 inches; dark brown (7.5YR 4/4) gravelly sandy clay loam; weak medium subangular blocky structure; friable; few faint dark brown (7.5YR 3/4) clay films on faces of peds; about 16 percent

gravel; strongly acid; clear wavy boundary.
Bt4—27 to 30 inches; dark brown (7.5YR 4/4) sandy loam; weak medium subangular blocky structure; very friable; few faint dark brown (7.5YR 3/4) clay films on faces of peds; about 10 percent gravel; medium acid; clear wavy boundary.
2BC—30 to 42 inches; dark brown (7.5YR 4/4) loamy sand; weak medium subangular blocky structure; very friable; about 5 percent gravel; slightly acid; gradual wavy boundary.
2C1—42 to 53 inches; dark brown (7.5YR 4/4) gravelly sand; weak fine granular structure; very friable; about 17 percent gravel; slightly acid; clear wavy boundary.
2C2—53 to 60 inches; dark yellowish brown (10YR 4/6) sand; single grained; loose; about 10 percent gravel; neutral.

The thickness of the solum ranges from 40 to 66 inches. The content of gravel ranges from 0 to 20 percent throughout the solum.

The Ap horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. The Bt horizon has hue of 10YR, 7.5YR, or 5YR, value of 3 to 5, and chroma of 2 to 6. It is clay loam, sandy clay loam, sandy loam, loam, or the gravelly analogs of those textures. The 2BC horizon has hue of 10YR, 7.5YR, or 5YR and value and chroma of 4 to 6. It is loamy sand, sand, or the gravelly analogs of those textures. Thin bands of sandy loam that have hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6 are common in the 2BC horizon in areas where the 2C horizon is below a depth of 60 inches. The 2C horizon has value of 4 to 6 and chroma of 3 to 6. In some pedons it has thin bands of loamy sand or sandy loam.

Napoleon Series

The Napoleon series consists of very poorly drained, moderately permeable or moderately rapidly permeable soils in closed depressions on lake plains and outwash plains. These soils formed in deposits of organic material more than 51 inches thick. Slopes range from 0 to 2 percent.

Typical pedon of Napoleon muck, 1,190 feet south and 915 feet west of the northeast corner of sec. 4, T. 5 S., R. 13 W.

Oa—0 to 8 inches; black (N 2/0) muck; about 30 percent fibers, 10 percent rubbed; weak thick platy structure; friable; many fine roots; herbaceous fibers; extremely acid; clear smooth boundary.
Oe1—8 to 17 inches; mucky peat, dark brown (7.5YR 3/2) rubbed; about 60 percent fibers, 25 percent rubbed; moderate thick platy structure; friable; herbaceous fibers; extremely acid; clear smooth boundary.
Oe2—17 to 50 inches; mucky peat, dark reddish brown (5YR 3/3) rubbed; about 70 percent fibers, 35 percent rubbed; moderate thick platy structure; friable; herbaceous fibers; some woody fragments; extremely acid; clear smooth boundary.
Oe3—50 to 60 inches; mucky peat, dark brown (7.5YR 3/2) rubbed; about 60 percent fibers, 25 percent rubbed; moderate thick platy structure; friable; herbaceous fibers; extremely acid.

The organic material ranges from 51 to more than 60 inches in thickness. Some pedons have 3 to 10 percent woody fragments that cannot be crushed between the fingers. The O horizon has hue of 10YR, 7.5YR, or 5YR, value of 2 to 5, and chroma of 1 to 3, or it is neutral in hue and has value of 2 to 5.

Ormas Series

The Ormas series consists of well drained soils on outwash plains and moraines. These soils formed in sandy and loamy material. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Slopes range from 0 to 12 percent.

Typical pedon of Ormas loamy sand, 0 to 6 percent slopes, 1,382 feet north and 329 feet east of the center of sec. 20, T. 5 S., R. 15 W.

Ap—0 to 9 inches; dark brown (10YR 3/3) loamy sand, brown (10YR 5/3) dry; weak coarse granular structure; very friable; common fine roots; neutral; abrupt smooth boundary.
Bw—9 to 24 inches; yellowish brown (10YR 5/4) loamy sand; weak medium granular structure; very friable; few fine roots; about 5 percent gravel; slightly acid; clear wavy boundary.
Bt—24 to 41 inches; dark yellowish brown (10YR 4/6) sandy loam; weak medium subangular blocky structure; friable; few distinct brown (7.5YR 4/4) clay films on pebbles and on faces of peds and clay bridges between sand grains; about 5 percent gravel; slightly acid; gradual wavy boundary.
2Bt—41 to 46 inches; yellowish brown (10YR 5/4) gravelly sandy loam; weak medium subangular blocky structure; friable; few distinct brown (7.5YR 4/4) clay films on pebbles and on faces of peds and clay bridges between sand grains; about 15 percent gravel; slightly acid; abrupt wavy boundary.
2C—46 to 60 inches; yellowish brown (10YR 5/8) gravelly loamy sand; single grained; loose; about 18 percent gravel; neutral.

The thickness of the solum ranges from 40 to 60 inches. The thickness of the upper sandy material ranges from 20 to 40 inches. The content of gravel ranges from 0 to 5 percent in the upper part of the solum and from 15 to 20 percent in the lower part and in the 2C horizon.

The Ap horizon has value of 3 or 4 and chroma of 2 to 6. The Bw horizon has value of 4 to 6 and chroma of 3 to 6. It is loamy sand or sand. The Bt horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 or 5, and chroma of 4 to 8. The 2Bt horizon is gravelly sandy loam or gravelly loam. The 2C horizon is gravelly loamy sand or gravelly sand.

Oshtemo Series

The Oshtemo series consists of well drained, moderately rapidly permeable soils on outwash plains and moraines. These soils formed in loamy and sandy material. Slopes range from 0 to 35 percent.

Typical pedon of Oshtemo sandy loam, 2 to 6 percent slopes, 400 feet north and 400 feet west of the southeast corner of sec. 32, T. 7 S., R. 13 W.

Ap—0 to 11 inches; dark brown (10YR 3/3) sandy loam, light yellowish brown (10YR 6/4) dry; weak medium granular structure; very friable; about 3 percent gravel; slightly acid; abrupt smooth boundary.

Bt1—11 to 14 inches; brown (7.5YR 5/4) sandy loam; weak medium subangular blocky structure; friable; few distinct dark brown (7.5YR 3/4) clay films on faces of peds; about 5 percent gravel; slightly acid; clear wavy boundary.

Bt2—14 to 28 inches; dark brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; few faint dark brown (7.5YR 3/4) clay films on faces of peds and on some pebbles; about 8 percent gravel; slightly acid; gradual wavy boundary.

Bt3—28 to 35 inches; dark brown (7.5YR 4/4) sandy loam; weak medium subangular blocky structure; friable; few faint dark brown (7.5YR 3/4) clay films on faces of peds; about 12 percent gravel; slightly acid; clear wavy boundary.

2BC—35 to 42 inches; strong brown (7.5YR 5/6) loamy sand; few discontinuous bands of dark brown (7.5YR 4/4) sandy loam ⅛ inch thick; weak medium granular structure; very friable; about 2 percent gravel; slightly acid; gradual smooth boundary.

2C—42 to 60 inches; yellowish brown (10YR 5/6) sand; few discontinuous bands of dark brown (7.5YR 4/4) sandy loam ⅛ inch thick; single grained; loose; about 3 percent gravel; slightly acid.

The thickness of the solum ranges from 40 to more than 60 inches. The content of coarse fragments ranges from 1 to 15 percent throughout the profile.

The Ap horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. The Bt horizon has hue of 10YR, 7.5YR, or 5YR, value of 3 to 5, and chroma of 4 to 6. It is dominantly sandy loam, gravelly sandy loam, or sandy clay loam. In some pedons, however, the lower part of this horizon has bands of sand or loamy sand ⅛ inch to 3 inches thick. The BC horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 4 to 6. The C horizon has value of 5 or 6 and chroma of 4 to 6. It is sand or gravelly sand.

Palms Series

The Palms series consists of very poorly drained soils in old lakebeds. These soils formed in deposits of organic material 16 to 50 inches deep over loamy deposits. Permeability is moderately slow to moderately rapid in the upper part of the profile and moderately slow or moderate in the loamy material. Slopes range from 0 to 2 percent.

Typical pedon of Palms muck, 2,155 feet west and 70 feet south of the center of sec. 9, T. 6 S., R. 13 W.

Oa1—0 to 12 inches; black (10YR 2/1) muck; weak medium granular structure; friable; medium acid; clear smooth boundary.

Oa2—12 to 26 inches; dark reddish brown (5YR 2/2) muck; moderate medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

Cg1—26 to 28 inches; light brownish gray (2.5Y 6/2), stratified fine sandy loam, loamy fine sand, and sandy clay loam; dark gray (10YR 4/1) organic stains; massive; friable; slightly acid; clear smooth boundary.

Cg2—28 to 33 inches; grayish brown (2.5Y 5/2) loamy sand; few fine distinct pale olive (5Y 6/3) mottles; about 3 percent gravel; massive; very friable; slightly acid; gradual wavy boundary.

Cg3—33 to 60 inches; grayish brown (2.5Y 5/2) and pale olive (5Y 6/3) sandy loam; dark gray (10YR 4/1) organic stains; massive; friable; about 12 percent gravel; slight effervescence; moderately alkaline.

The surface layer has hue of 10YR or 7.5YR and chroma of 1 or 2, or it is neutral in hue. It is dominantly sapric material, but the range includes hemic material. The subsurface tier has hue of 10YR, 7.5YR, or 5YR, value of 2 to 4, and chroma of 1 to 3, or it is neutral in hue and has value of 2 to 4. Some pedons have layers of hemic material 4 to 7 inches thick.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 6, and chroma of 1 or 2. It is dominantly silty clay loam, clay loam, sandy loam, fine sandy loam, or silt loam. In some pedons, however, it has strata of loamy sand, loamy fine sand, sandy clay loam, or fine sand. The content of coarse fragments in this horizon ranges from 0 to 14 percent.

Riddles Series

The Riddles series consists of well drained, moderately permeable soils on moraines and till plains. These soils formed in loamy material. Slopes range from 6 to 35 percent.

Typical pedon of Riddles fine sandy loam, 6 to 12 percent slopes, 1,120 feet west and 1,920 feet north of the center of sec. 18, T. 6 S., R. 13 W.

Ap—0 to 7 inches; dark brown (10YR 3/3) fine sandy loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; friable; many fine roots; about 1 percent gravel; neutral; abrupt smooth boundary.

Bt1—7 to 22 inches; brown (7.5YR 5/4) clay loam; moderate medium subangular blocky structure; firm; few fine roots; few faint dark brown (7.5YR 4/4) clay films on faces of peds; about 1 percent gravel; neutral; gradual smooth boundary.

Bt2—22 to 34 inches; brown (7.5YR 5/4) loam; moderate medium subangular blocky structure; firm; few fine roots; few faint dark brown (7.5YR 4/4) clay films on faces of peds; about 1 percent gravel; slightly acid; gradual wavy boundary.

Bt3—34 to 42 inches; brown (7.5YR 5/4) sandy loam; weak medium subangular blocky structure; friable; few faint dark brown (7.5YR 4/4) clay films on vertical faces of peds; about 1 percent gravel; slightly acid; gradual wavy boundary.

BC—42 to 60 inches; yellowish brown (10YR 5/6) sandy loam; weak fine subangular blocky structure; friable; about 1 percent gravel; neutral.

The solum ranges from 40 to 80 inches in thickness. The content of coarse fragments ranges from 1 to 8 percent throughout the solum.

The Ap horizon has value of 3 or 4 and chroma of 2 or 3. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It is dominantly clay loam, sandy loam, or loam, but in some pedons it has thin subhorizons of silty clay loam. The BC horizon has colors and textures similar to those of the C horizon. Some pedons have a calcareous C horizon. This horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. It is loam or sandy loam.

Schoolcraft Series

The Schoolcraft series consists of well drained soils on outwash plains. These soils formed in loamy sediments over sandy sediments. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 4 percent.

Typical pedon of Schoolcraft loam, 0 to 2 percent slopes, 1,320 feet south and 980 feet east of the center of sec. 21, T. 6 S., R. 15 W.

Ap—0 to 11 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (2.5Y 5/2) dry; weak medium subangular blocky structure; friable; many fine roots; slightly acid; abrupt smooth boundary.

Bt1—11 to 22 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; firm; about 3 percent gravel; common fine roots; few distinct dark grayish brown (10YR 4/2) clay films on faces of peds; strongly acid; gradual wavy boundary.

Bt2—22 to 29 inches; dark yellowish brown (10YR 4/4) sandy clay loam; moderate medium subangular blocky structure; firm; about 3 percent gravel; few fine roots; few distinct dark grayish brown (10YR 4/2) clay films on vertical faces of peds; strongly acid; gradual wavy boundary.

BC—29 to 33 inches; dark yellowish brown (10YR 4/4) sandy loam; weak medium subangular blocky structure; friable; about 10 percent gravel; strongly acid; clear smooth boundary.

2C—33 to 63 inches; yellowish brown (10YR 5/6) sand; few thin bands of dark yellowish brown (10YR 4/4) loamy sand; common medium dark yellowish brown (10YR 3/4) nodules; single grained; loose; about 3 percent gravel; medium acid.

The thickness of the solum ranges from 25 to 50 inches. The content of gravel ranges from 0 to 10 percent in the solum and from 3 to 20 percent in the 2C horizon.

The Ap horizon has value of 2 or 3 and chroma of 1 to 3. The Bt horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 2 to 4. The BC horizon has colors similar to those of the Bt horizon. The 2C horizon has value of 4 to 6 and chroma of 3 to 6. It is dominantly sand or gravelly sand but has bands of loamy sand. The bands have colors similar to those of the Bt horizon. They range from ⅛ inch to 5 inches in thickness.

Spinks Series

The Spinks series consists of well drained, moderately rapidly permeable or rapidly permeable soils

on outwash plains and moraines. These soils formed in sandy material. Slopes range from 0 to 35 percent.

Typical pedon of Spinks loamy sand, 0 to 6 percent slopes, 780 feet south and 2,485 feet west of the northeast corner of sec. 10, T. 5 S., R. 16 W.

Ap—0 to 10 inches; dark brown (10YR 3/3) loamy sand, pale brown (10YR 6/3) dry; weak fine granular structure; very friable; common fine roots; slightly acid; abrupt smooth boundary.

E—10 to 18 inches; yellowish brown (10YR 5/6) loamy fine sand; weak fine subangular blocky structure; very friable; few fine roots; medium acid; gradual smooth boundary.

E&Bt1—18 to 30 inches; yellowish brown (10YR 5/6) loamy sand (E); weak fine granular structure; lamellae of dark brown (7.5YR 4/4) sandy loam (Bt); weak fine subangular blocky structure; very friable; few fine roots; medium acid; gradual smooth boundary.

E&Bt2—30 to 53 inches; dark yellowish brown (10YR 4/4) loamy sand (E); weak fine granular structure; very friable; lamellae of dark brown (7.5YR 4/4) sandy loam (Bt); weak medium subangular blocky structure; friable; about 14 percent gravel; slightly acid; gradual smooth boundary.

C—53 to 60 inches; brown (10YR 5/3) sand; single grained; loose; about 7 percent gravel; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 36 to more than 60 inches. The content of coarse fragments ranges from 0 to 14 percent throughout the profile.

The Ap horizon has value of 3 or 4 and chroma of 2 to 4. The E horizon has value of 4 to 6 and chroma of 3 to 6. It is sand, loamy sand, fine sand, or loamy fine sand. The B horizon occurs as lamellae ⅛ inch to 4 inches thick. The lamellae have a total thickness of more than 6 inches. They have hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. They are loamy sand or sandy loam. The C horizon has value of 5 or 6 and chroma of 3 or 4. It is sand or fine sand.

Teasdale Series

The Teasdale series consists of somewhat poorly drained, moderately permeable soils on till plains. These soils formed in loamy material. Slopes range from 0 to 3 percent.

The Teasdale soils in this county are taxadjuncts to the series because they have tongues of albic material in the Bt horizon. This difference, however, does not affect the use or behavior of the soils.

Typical pedon of Teasdale fine sandy loam, 0 to 3 percent slopes, 50 feet south and 1,300 feet east of the center of sec. 10, T. 8 S., R. 14 W.

Ap—0 to 9 inches; dark brown (10YR 3/3) fine sandy loam, light brownish gray (10YR 6/2) dry; weak medium granular structure; friable; many fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

E—9 to 17 inches; brown (10YR 5/3) fine sandy loam; weak medium subangular blocky structure; friable; many fine roots; about 2 percent gravel; neutral; clear smooth boundary.

B/E—17 to 31 inches; dark yellowish brown (10YR 4/4) loam (B); few fine distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; tongues of brown (10YR 5/3) fine sandy loam (E); weak fine granular structure; friable; common fine roots; about 3 percent gravel; medium acid; clear wavy boundary.

Bt—31 to 48 inches; yellowish brown (10YR 5/6) loam; few fine distinct grayish brown (10YR 5/2) mottles; moderate coarse subangular blocky structure; friable; few distinct dark brown (10YR 4/3) clay films on the faces of peds; few distinct coatings of brown (10YR 5/3) fine sandy loam (E) on vertical faces of peds; about 2 percent gravel; slightly acid; gradual wavy boundary.

C—48 to 60 inches; yellowish brown (10YR 5/4) fine sandy loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 3 percent gravel; mildly alkaline.

The solum ranges from 40 to 60 inches in thickness. The content of coarse fragments ranges from 0 to 8 percent throughout the profile.

The Ap horizon has value of 3 or 4 and chroma of 2 or 3. The E horizon has value of 5 or 6 and chroma of 2 to 4. It is fine sandy loam or sandy loam. The E part of the B/E horizon consists of coatings, 2 to 5 millimeters thick, on the vertical faces of peds. The B part has colors and textures similar to those of the Bt horizon. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It is loam or sandy loam. The C horizon is fine sandy loam or sandy loam.

Tedrow Series

The Tedrow series consists of somewhat poorly drained, rapidly permeable soils on outwash plains and in glacial drainageways. These soils formed in sandy material. Slopes range from 0 to 3 percent.

Typical pedon of Tedrow loamy sand, 0 to 3 percent slopes, 120 feet east and 950 feet north of the southwest corner of sec. 12, T. 6 S., R. 16 W.

Ap—0 to 9 inches; dark brown (10YR 4/3) loamy sand; pale brown (10YR 6/3) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

Bw1—9 to 12 inches; strong brown (7.5YR 5/6) loamy sand; many coarse distinct reddish yellow (7.5YR 6/8) mottles; weak fine granular structure; very friable; slightly acid; clear wavy boundary.

Bw2—12 to 24 inches; strong brown (7.5YR 5/6) sand; many coarse prominent light gray (N 7/0) and few fine prominent light brownish gray (10YR 6/2) mottles; single grained; loose; slightly acid; clear wavy boundary.

BC—24 to 34 inches; pale brown (10YR 6/3) sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grained; loose; neutral; clear smooth boundary.

C1—34 to 38 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; neutral; clear smooth boundary.

C2—38 to 60 inches; pale brown (10YR 6/3) sand; single grained; loose; neutral.

The thickness of the solum ranges from 24 to 46 inches. The content of gravel is 0 to 2 percent throughout the profile.

The Ap horizon has value of 3 or 4 and chroma of 1 to 3. The Bw horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 to 6. The C horizon has value of 4 to 6 and chroma of 1 to 4. It is sand or fine sand.

Formation of the Soils

This section relates the factors of soil formation to the soils in Cass County and explains the processes of soil formation.

Factors of Soil Formation

Soil forms through the interaction of five major factors—the physical, chemical, and mineral composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soils; the relief, or lay of the land; and the length of time that the processes of soil formation have acted on the parent material *(6)*.

Climate and plant and animal life are the active forces of soil formation. They slowly change the parent material into a natural body of soil that has genetically related layers, called horizons. The effects of climate and plant and animal life are conditioned by relief. The nature of the parent material affects the kind of soil profile that forms. In extreme cases, it determines the soil profile almost entirely. Finally, time is needed for the differentiation of soil horizons.

The factors of soil formation are so closely related in their effects on the soils that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. It determines the limits of the chemical and mineralogical composition of the soil. The parent materials of the soils of Cass County were deposited by glaciers or by meltwater from the glaciers, which covered the county 10,000 to 12,000 years ago. Some of these parent materials have been reworked and redeposited by the subsequent action of water and wind. Although most of the parent materials are of common glacial origin, their properties vary greatly, sometimes within small areas, depending on how the materials were deposited. The dominant parent materials in Cass County were deposited as glacial till, outwash, alluvium, and organic material.

Glacial till was deposited directly by glaciers with a minimum of water action. It is a mixture of particles of different sizes. The small pebbles in glacial till have sharp corners, indicating that they have not been worn by water. The glacial till in Cass County generally is deeply leached loam or sandy loam. Cassopolis soils are an example of soils that formed in glacial till.

Outwash material was deposited by running water from melting glaciers. The size of the particles depends on the speed of the stream that carried the material. When the water slowed down, the coarser particles were deposited. The finer particles, such as very fine sand, silt, and clay, were carried by slowly moving water. Outwash deposits generally occur as layers of similarly sized particles, such as sand, gravel, and other coarse particles. Kalamazoo soils are an example of soils that formed in outwash material.

Alluvium was recently deposited by floodwater along streams. It varies in texture, depending on the speed of the water from which it was deposited. Cohoctah soils formed in alluvium.

Organic material occurs as deposits of plant remains. After the glaciers withdrew from the survey area, water was left standing in depressions on outwash plains, flood plains, moraines, and till plains. Grasses and sedges growing around the edges of these lakes died, and their residue fell to the bottom. Because the areas were wet, the plant remains did not decompose but remained around the edge of the lake. Later, water-tolerant trees grew in the areas. After these trees died, their residue became part of the organic accumulation. Eventually, the lakes were filled with organic material and developed into areas of muck. Adrian soils are an example of soils that formed in organic material.

Plant and Animal Life

Plants have affected the soils in Cass County more significantly than the other living organisms. Bacteria, fungi, and earthworms, however, also have been important. The chief contribution of plant and animal life is the addition of organic material and nitrogen to the soil. The kind of organic matter on and in the soil depends on the kinds of native plants that grew on the soil. The remains of these plants accumulated on the surface, decayed, and eventually became organic

matter. The roots of the plants provided channels for the downward movement of water through the soil and added organic matter as they decayed. Bacteria in the soil helped to break down the organic matter into plant nutrients.

The native vegetation in Cass County was mainly deciduous trees, but conifers grew on the sandy soils. Differences in natural soil drainage and parent material have affected the composition of the forest species. The well drained soils on uplands, such as Kalamazoo and Oshtemo soils, generally were covered by sugar maple, oak, and beech. The very poorly drained Gilford and poorly drained Barry soils were covered by soft maple, ash, and elm.

Climate

Climate determines the kind of plant and animal life on and in the soil and the amount of water available for the weathering of minerals and the translocation of soil material. Through its influence on soil temperature, climate also determines the rate of chemical reaction in the soil.

The climate in Cass County is cool and humid. Presumably, it is similar to that under which the soils formed. The soils in the county differ from the soils that formed under a moist, hot climate. The climate is uniform throughout the county, but its effect is modified locally by the proximity to Lake Michigan. Only minor differences among the soils in the county are the result of climatic differences.

Relief

Relief has markedly affected the soils in Cass County through its influence on natural drainage, runoff, erosion, plant cover, and soil temperature. Slopes range from 0 to 35 percent. Natural soil drainage ranges from excessively drained on hilltops to very poorly drained in depressions.

Through its effect on soil aeration, drainage influences the color of the soil. Runoff is most rapid on the steeper slopes. In some low areas, water is temporarily ponded. Water and air move freely through well drained soils but slowly through very poorly drained soils. In Oshtemo and other well aerated, well drained soils, the iron and aluminum compounds that give most soils their color are brightly colored and oxidized. Poorly aerated, poorly drained soils are dull gray and mottled. Barry soils are an example.

Time

Generally, a long time is needed for the development of distinct soil horizons. Differences in length of time that the parent material has been in place are commonly reflected in the degree of profile development. Some soils form rapidly. Others form slowly.

The soils in Cass County range from young to mature. Most of the soils that formed in glacial deposits have been exposed to the soil-forming processes long enough for the development of distinct horizons. Kalamazoo soils are an example of older soils. Soils that formed in recent alluvial sediments are considered young. They have not been in place long enough for the differentiation of distinct horizons.

Processes of Soil Formation

Several processes were involved in the development of horizons in the soils of Cass County. These were the accumulation of organic matter, the leaching of lime (calcium carbonate) and other bases, the reduction and transfer of iron, and the formation and translocation of clay minerals. More than one of these processes have helped to differentiate horizons in most of the soils.

As organic matter accumulated at the surface, an A horizon formed. If the soil is plowed, the A horizon is mixed into a plow layer, or Ap horizon. The surface layer of the soils in Cass County ranges from high to low in content of organic matter. The content is high, for example, in Schoolcraft soils and low in Spinks soils.

The leaching of carbonates and other bases has occurred in most of the soils. The leaching of bases usually precedes the translocation of silicate clay minerals. Many of the soils are moderately leached or strongly leached. Riddles soils, for example, are leached to a depth of 40 to 60 inches. Differences in the depth of leaching are the result of time and parent material.

Gleying, or the reduction and transfer of iron, is evident in somewhat poorly drained to very poorly drained soils. Barry soils are an example. A gray color in the subsoil indicates the reduction and loss of iron.

The translocation of clay minerals contributes to horizon development. An eluviated, or leached, E horizon is lower in content of clay and typically is lighter in color than an illuviated B horizon. The B horizon typically has an accumulation of clay (clay films) in pores and on the faces of peds. Soils in which clay has been translocated were probably leached of carbonates and soluble salts to a considerable extent before the translocation of clay took place. Oshtemo soils are an example of soils in which clay in the form of clay films has accumulated in the B horizon.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Graded stripcropping. Growing crops in strips that grade toward a protected waterway.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent,

by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.
Sprinkler.—Water is sprayed over the surface through pipes or nozzles from a pressure system.
Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.
Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on

features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are—

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then

multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. The slope classes in this survey are—

Nearly level	0 to 3 percent
Nearly level and undulating	0 to 6 percent
Undulating	2 to 6 percent
Gently rolling	6 to 12 percent
Hilly	12 to 18 percent
Steep	18 to 25 percent

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the substratum. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tier. A layer of organic soil material.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-80)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average daily	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
DOWAGIAC:											
January-----	31.0	14.9	23.0	55	-13	0	2.41	1.3	3.4	6	21.1
February----	34.9	17.0	26.0	57	-12	0	1.82	1.1	2.5	5	14.1
March-------	45.5	26.2	35.9	76	-1	19	2.59	1.5	3.5	7	9.6
April-------	60.3	37.2	48.8	83	17	114	3.82	2.5	5.0	8	1.7
May---------	71.5	46.3	58.9	90	25	311	3.07	2.0	4.1	7	.0
June--------	80.8	55.5	68.2	95	36	552	3.84	2.3	5.2	7	.0
July--------	84.2	59.1	71.7	96	43	679	3.86	2.2	5.3	6	.0
August------	82.5	57.8	70.2	95	39	632	3.36	1.9	4.7	6	.0
September---	76.0	50.8	63.4	93	30	412	3.41	1.1	5.3	6	.0
October-----	64.4	41.0	52.7	84	20	166	3.46	1.6	5.0	7	.6
November----	49.0	31.5	40.3	73	9	29	2.86	1.8	3.8	8	8.6
December----	36.1	21.3	28.7	61	-6	0	2.94	1.6	4.1	8	18.3
Year-------	59.7	38.2	49.0	97	-16	2,914	37.44	32.8	42.6	81	74.0
EAU CLAIRE:											
January-----	30.3	16.5	23.4	56	-10	0	2.32	1.3	3.2	7	21.5
February----	33.7	19.0	26.4	57	-7	0	1.58	.9	2.2	5	13.2
March-------	44.2	27.4	35.8	74	5	17	2.45	1.5	3.3	7	7.3
April-------	58.9	38.3	48.6	82	19	109	3.70	2.5	4.8	8	1.9
May---------	70.2	48.1	59.2	89	29	316	3.18	2.0	4.2	6	.0
June--------	79.7	57.8	68.7	94	35	570	3.46	2.1	4.7	7	.0
July--------	83.2	61.9	72.6	95	48	707	3.26	1.9	4.5	6	.0
August------	81.5	60.6	71.1	94	45	660	3.14	1.6	4.5	6	.0
September---	74.8	54.0	64.4	93	36	441	3.38	1.1	5.3	6	.0
October-----	63.0	43.7	53.4	84	25	176	3.18	1.6	4.6	7	.8
November----	47.8	32.9	40.4	72	10	30	2.76	1.9	3.6	8	8.0
December----	35.3	22.6	29.0	60	-1	0	2.71	1.7	3.6	8	17.1
Year-------	58.6	40.2	49.4	97	-12	3,026	35.12	30.9	39.2	81	69.8

See footnotes at end of table.

TABLE 1.--TEMPERATURE AND PRECIPITATION--Continued

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average daily	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
THREE RIVERS:											
January	30.6	15.3	23.0	56	-12	0	1.84	0.9	2.7	5	11.1
February	34.5	17.3	25.9	58	-11	0	1.49	.7	2.2	4	8.9
March	45.0	26.4	35.7	75	1	18	2.44	1.5	3.3	6	7.1
April	60.0	37.2	48.6	83	18	109	3.35	2.0	4.6	8	1.9
May	71.6	46.8	59.2	89	27	316	3.12	1.8	4.3	7	**
June	80.8	56.1	68.5	95	37	561	3.95	2.5	5.3	7	.0
July	84.1	59.7	72.0	96	44	688	3.79	2.3	5.2	7	.0
August	82.4	57.9	70.2	95	40	633	3.16	1.5	4.6	6	.0
September	75.9	50.8	63.4	93	30	412	3.01	1.1	4.6	6	.0
October	63.9	40.5	52.2	85	20	156	2.71	1.3	3.9	6	.3
November	48.2	31.3	39.8	72	9	27	2.38	1.6	3.1	6	5.4
December	35.7	21.3	28.5	61	-6	0	2.32	1.1	3.4	6	11.2
Year	59.4	38.4	48.9	97	-15	2,920	33.56	28.7	38.3	74	45.9

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

** Average is less than .1 inch.

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1930-79)

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
EAU CLAIR:			
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 20	May 1	May 15
2 years in 10 later than--	Apr. 14	Apr. 26	May 10
5 years in 10 later than--	Apr. 4	Apr. 18	May 2
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 29	Oct. 19	Oct. 5
2 years in 10 earlier than--	Nov. 4	Oct. 24	Oct. 10
5 years in 10 earlier than--	Nov. 14	Nov. 3	Oct. 20
THREE RIVERS:			
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 24	May 12	May 21
2 years in 10 later than--	Apr. 20	May 7	May 16
5 years in 10 later than--	Apr. 12	Apr. 27	May 7
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 16	Oct. 2	Sept. 19
2 years in 10 earlier than--	Oct. 21	Oct. 7	Sept. 24
5 years in 10 earlier than--	Nov. 1	Oct. 18	Oct. 4

TABLE 3.--GROWING SEASON

(Recorded in the period 1930-79)

Probability	Daily minimum temperature		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
EAU CLAIR:			
9 years in 10	200	179	152
8 years in 10	208	186	158
5 years in 10	223	199	170
2 years in 10	238	212	182
1 year in 10	246	219	189
THREE RIVERS:			
9 years in 10	182	153	129
8 years in 10	189	160	136
5 years in 10	203	173	149
2 years in 10	217	186	162
1 year in 10	224	193	169

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
2	Histosols and Aquents, ponded	3,612	1.1
3A	Schoolcraft loam, 0 to 2 percent slopes	5,130	1.6
3B	Schoolcraft loam, 2 to 4 percent slopes	2,063	0.6
4A	Oshtemo sandy loam, 0 to 2 percent slopes	4,845	1.5
4B	Oshtemo sandy loam, 2 to 6 percent slopes	27,143	8.5
4C	Oshtemo sandy loam, 6 to 12 percent slopes	12,427	3.9
4D	Oshtemo sandy loam, 12 to 18 percent slopes	3,123	1.0
5B	Spinks loamy sand, 0 to 6 percent slopes	23,657	7.4
5C	Spinks loamy sand, 6 to 12 percent slopes	5,746	1.8
9A	Kalamazoo loam, 0 to 2 percent slopes	27,019	8.5
9B	Kalamazoo loam, 2 to 6 percent slopes	51,981	16.5
9C	Kalamazoo loam, 6 to 12 percent slopes	11,993	3.8
9D	Kalamazoo loam, 12 to 18 percent slopes	2,341	0.7
11	Edwards muck	543	0.2
12A	Brady sandy loam, 0 to 2 percent slopes	3,981	1.3
15	Glendora muck	5,440	1.7
16B	Ormas loamy sand, 0 to 6 percent slopes	9,952	3.1
16C	Ormas loamy sand, 6 to 12 percent slopes	934	0.3
18	Barry loam	1,846	0.6
19	Houghton muck	18,626	5.9
20A	Bronson loamy sand, 0 to 3 percent slopes	2,339	0.7
24	Adrian muck	7,358	2.3
26C	Riddles fine sandy loam, 6 to 12 percent slopes	4,527	1.4
26D	Riddles fine sandy loam, 12 to 18 percent slopes	1,665	0.5
26E	Riddles fine sandy loam, 18 to 35 percent slopes	2,174	0.7
27A	Tedrow loamy sand, 0 to 3 percent slopes	1,247	0.4
28A	Teasdale fine sandy loam, 0 to 3 percent slopes	6,674	2.1
29	Palms muck	2,201	0.7
30A	Elston sandy loam, 0 to 2 percent slopes	1,928	0.6
30B	Elston sandy loam, 2 to 6 percent slopes	1,015	0.3
34	Pits	966	0.3
36	Gilford sandy loam	6,537	2.1
37B	Brems loamy sand, 0 to 6 percent slopes	1,375	0.4
38	Napoleon muck	1,681	0.5
39	Cohoctah loam	4,761	1.5
40B	Coloma loamy sand, 0 to 6 percent slopes	3,835	1.2
40C	Coloma loamy sand, 6 to 12 percent slopes	2,189	0.7
41B	Spinks-Oshtemo complex, 2 to 6 percent slopes	1,837	0.6
41C	Spinks-Oshtemo complex, 6 to 12 percent slopes	6,226	2.0
41D	Spinks-Oshtemo complex, 12 to 18 percent slopes	10,070	3.2
41E	Spinks-Oshtemo complex, 18 to 35 percent slopes	5,952	1.9
42	Udipsamments and Udorthents, nearly level	899	0.3
44B	Urban land-Spinks complex, 0 to 6 percent slopes	1,146	0.4
45B	Urban land-Kalamazoo complex, 0 to 6 percent slopes	660	0.2
46B	Cassopolis fine sandy loam, 3 to 6 percent slopes	14,388	4.5
	Water areas less than 40 acres in size	1,529	0.5
	Total	317,581	100.0

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
3A	Schoolcraft loam, 0 to 2 percent slopes
3B	Schoolcraft loam, 2 to 4 percent slopes
4A	Oshtemo sandy loam, 0 to 2 percent slopes
4B	Oshtemo sandy loam, 2 to 6 percent slopes
9A	Kalamazoo loam, 0 to 2 percent slopes
9B	Kalamazoo loam, 2 to 6 percent slopes
12A	Brady sandy loam, 0 to 2 percent slopes (where drained)
18	Barry loam (where drained)
20A	Bronson loamy sand, 0 to 3 percent slopes (where drained)
28A	Teasdale fine sandy loam, 0 to 3 percent slopes (where drained)
30A	Elston sandy loam, 0 to 2 percent slopes
30B	Elston sandy loam, 2 to 6 percent slopes
36	Gilford sandy loam (where drained)
39	Cohoctah loam (where drained and either protected from flooding or not frequently flooded during the growing season)
46B	Cassopolis fine sandy loam, 3 to 6 percent slopes

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Corn	Corn silage	Oats	Winter wheat	Soybeans	Bromegrass-alfalfa hay
		Bu	Tons	Bu	Bu	Bu	Tons
2. Histosols and Aquents							
3A--Schoolcraft	IIs	120	19	95	60	35	---
3B--Schoolcraft	IIe	120	18	95	60	32	---
4A--Oshtemo	IIIs	95	16	80	45	30	2.5
4B--Oshtemo	IIIe	95	10	80	45	30	2.5
4C--Oshtemo	IIIe	90	15	75	40	26	2.5
4D--Oshtemo	IVe	80	13	70	35	21	2.2
5B--Spinks	IIIs	75	13	60	30	27	3.0
5C--Spinks	IIIe	68	12	55	30	23	2.4
9A--Kalamazoo	IIs	100	18	80	40	30	2.8
9B--Kalamazoo	IIe	95	17	80	40	30	2.8
9C--Kalamazoo	IIIe	85	16	75	38	27	2.7
9D--Kalamazoo	IVe	65	13	65	36	24	2.5
11--Edwards	Vw	---	---	---	---	---	---
12A--Brady	IIw	115	19	95	50	33	3.2
15--Glendora	VIw	---	---	---	---	---	---
16B--Ormas	IIIe	80	17	---	36	28	---
16C--Ormas	IIIe	70	16	---	32	24	---
18--Barry	IIw	120	19	100	55	35	4.8

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability	Corn	Corn silage	Oats	Winter wheat	Soybeans	Bromegrass-alfalfa hay
		Bu	Tons	Bu	Bu	Bu	Tons
19--- Houghton	Vw	---	---	---	---	---	---
20A--- Bronson	IIs	100	17	80	40	30	2.8
24--- Adrian	Vw	---	---	---	---	---	---
26C--- Riddles	IIIe	105	19	---	47	37	2.8
26D--- Riddles	IVe	85	---	---	38	30	2.5
26E--- Riddles	VIe	---	---	---	---	---	---
27A--- Tedrow	IIIs	85	---	---	35	30	---
28A--- Teasdale	IIw	115	19	90	50	33	---
29--- Palms	Vw	---	---	---	---	---	---
30A--- Elston	IIs	90	18	---	40	32	---
30B--- Elston	IIe	90	18	---	40	32	---
34. Pits							
36--- Gilford	Vw	---	---	---	---	---	---
37B--- Brems	IVs	70	16	45	32	24	2.3
38--- Napoleon	VIw	---	---	---	---	---	---
39--- Cohoctah	Vw	---	---	---	---	---	---
40B--- Coloma	IVs	45	7	45	---	18	2.5
40C--- Coloma	VIs	---	---	---	---	---	2.0
41B--- Spinks-Oshtemo	IIIs	84	11	69	37	28	2.8
41C--- Spinks-Oshtemo	IIIe	78	14	64	35	24	2.4

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability	Corn	Corn silage	Oats	Winter wheat	Soybeans	Bromegrass-alfalfa hay
		Bu	Tons	Bu	Bu	Bu	Tons
41D--Spinks-Oshtemo	IVe	---	---	59	28	---	2.0
41E--Spinks-Oshtemo	VIIe	---	---	---	---	---	---
42. Udipsamments and Udorthents							
44B. Urban land-Spinks							
45B. Urban land-Kalamazoo							
46B--Cassopolis	IIe	115	18	---	46	40	3.4

TABLE 7.--CAPABILITY CLASSES AND SUBCLASSES

(Miscellaneous areas are excluded. Absence of an entry indicates no acreage)

Class	Total acreage	Major management concerns (Subclass)		
		Erosion (e)	Wetness (w)	Soil problem (s)
		Acres	Acres	Acres
I	---	---	---	---
II	119,024	70,107	12,501	36,416
III	111,610	78,878	---	32,732
IV	22,409	17,199	---	5,210
V	40,026	---	40,026	---
VI	11,484	2,174	7,121	2,189
VII	5,952	5,952	---	---
VIII	---	---	---	---

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available)

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
4A, 4B, 4C, 4D--Oshtemo	4A	Slight	Slight	Slight	Slight	Northern red oak----	66	60	Eastern white pine, red pine, white spruce.
						White oak----------	---	---	
						American basswood---	66	60	
						Sugar maple---------	61	38	
5B, 5C----------Spinks	4A	Slight	Slight	Slight	Slight	Northern red oak----	66	60	Red pine, eastern white pine.
						White oak----------	---	---	
						Black oak----------	---	---	
						Black cherry--------	---	---	
9A, 9B, 9C, 9D--Kalamazoo	4A	Slight	Slight	Slight	Slight	Northern red oak----	65	59	Black walnut, yellow poplar, eastern white pine, white spruce, red pine.
						White ash----------	65	59	
						Black walnut--------	65	---	
						White oak----------	---	---	
						Black cherry--------	---	---	
						American basswood---	65	59	
						Sugar maple---------	61	38	
11----------Edwards	2W	Slight	Severe	Severe	Severe	Red maple----------	56	36	
						White ash----------	---	---	
						Green ash----------	---	---	
						Tamarack-----------	---	---	
						Swamp white oak-----	---	---	
						Silver maple--------	---	---	
12A----------Brady	3W	Slight	Moderate	Slight	Slight	Red maple----------	61	38	Eastern white pine, white spruce.
						White ash----------	---	---	
						Quaking aspen-------	---	---	
						Silver maple--------	---	---	
						Bitternut hickory---	---	---	
						Swamp white oak-----	---	---	
						American basswood---	61	53	
15----------Glendora	3W	Slight	Severe	Moderate	Moderate	Silver maple--------	90	42	
						Red maple----------	65	40	
						Swamp white oak-----	---	---	
						Quaking aspen-------	---	---	
						Black ash----------	---	---	
						Eastern cottonwood--	---	---	
						White ash----------	65	59	
16B, 16C--------Ormas	3S	Slight	Slight	Moderate	Slight	Black oak----------	65	48	Black walnut, red pine, eastern white pine, yellow poplar, white oak.
						White oak----------	66	60	
						Bigtooth aspen------	75	87	
						Black cherry--------	---	---	
						Yellow poplar-------	---	---	

See footnote at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
18--Barry	2W	Slight	Severe	Severe	Severe	Red maple	56	36	
						White ash	---	---	
						Eastern cottonwood	---	---	
						Silver maple	---	---	
						Swamp white oak	---	---	
						American sycamore	---	---	
						Bitternut hickory	---	---	
						Pin oak	---	---	
19--Houghton	2W	Slight	Severe	Severe	Severe	Silver maple	82	36	
						Red maple	56	36	
						White ash	---	---	
						Quaking aspen	---	---	
						Tamarack	---	---	
						Green ash	---	---	
20A--Bronson	4A	Slight	Slight	Slight	Slight	Northern red oak	66	60	Eastern white pine, red pine, black walnut.
						White oak	66	60	
						Sugar maple	61	38	
						American beech	---	---	
						American basswood	---	---	
						Shagbark hickory	---	---	
						Black walnut	---	---	
24--Adrian	2W	Slight	Severe	Severe	Severe	Silver maple	78	32	
						Red maple	53	34	
						White ash	---	---	
						Quaking aspen	---	---	
						Tamarack	---	---	
						Green ash	---	---	
26C, 26D--Riddles	5A	Slight	Slight	Slight	Slight	Northern red oak	75	73	Black walnut, eastern white pine, red pine, white spruce.
						Red maple	75	47	
						White ash	75	73	
						Green ash	75	41	
						Black walnut	---	---	
						Yellow poplar	---	---	
26E--Riddles	5R	Moderate	Moderate	Slight	Slight	Northern red oak	75	73	Black walnut, eastern white pine, red pine, white spruce.
						Red maple	75	47	
						White ash	75	73	
						Green ash	75	41	
						Black walnut	---	---	
						Yellow poplar	---	---	
27A--Tedrow	2S	Slight	Moderate	Moderate	Slight	White ash	55	42	Eastern white pine, white spruce.
						Silver maple	---	---	
						Eastern white pine	---	---	
28A--Teasdale	4W	Slight	Moderate	Slight	Slight	Northern red oak	66	60	White spruce, eastern white pine.
						Red maple	---	---	
						White ash	---	---	
						Eastern cottonwood	---	---	
						American basswood	---	---	
						Northern pin oak	---	---	

See footnote at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Potential productivity: Common trees	Site index	Volume*	Trees to plant
29-------------- Palms	2W	Slight	Severe	Severe	Severe	Red maple---------- Silver maple-------- White ash---------- Quaking aspen------- Tamarack---------- Black ash----------	55 --- --- --- --- ---	35 --- --- --- --- ---	
36-------------- Gilford	2W	Slight	Severe	Severe	Severe	Silver maple-------- American basswood--- Pin oak---------- Red maple---------- White ash---------- Swamp white oak----- Bur oak----------	70 --- --- --- --- --- ---	25 --- --- --- --- --- ---	
37B------------- Brems	3A	Slight	Slight	Slight	Slight	Pin oak---------- Black oak---------- White oak---------- Jack pine----------	59 --- --- 55	42 --- --- 77	Eastern white pine, red pine, jack pine.
38-------------- Napoleon	2W	Slight	Severe	Severe	Severe	Red maple---------- Silver maple-------- White ash---------- Quaking aspen------- Tamarack---------- Black ash---------- Swamp white oak-----	56 --- --- --- --- --- ---	36 --- --- --- --- --- ---	
39-------------- Cohoctah	2W	Slight	Severe	Moderate	Moderate	Silver maple-------- Red maple---------- White ash---------- Swamp white oak----- Eastern cottonwood-- American sycamore---	80 56 --- --- --- ---	34 36 --- --- --- ---	
40B, 40C--------- Coloma	2S	Slight	Moderate	Moderate	Slight	Northern pin oak---- Jack pine---------- Black oak---------- White oak---------- Eastern white pine--	49 --- --- --- ---	33 --- --- --- ---	Red pine, eastern white pine, jack pine.
41B, 41C, 41D: Spinks--------- Oshtemo-------- 	4A 4A 	Slight Slight 	Slight Slight 	Slight Slight 	Slight Slight 	Northern red oak---- White oak---------- Black oak---------- Black cherry-------- Northern red oak---- White oak---------- American basswood--- Sugar maple---------	66 --- --- --- 66 --- 66 61	60 --- --- --- 60 --- 60 38	Red pine, eastern white pine. Eastern white pine, red pine, white spruce.

See footnote at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
41E:									
Spinks	4R	Moderate	Moderate	Slight	Slight	Northern red oak	66	60	Red pine, eastern white pine.
						White oak	---	---	
						Black oak	---	---	
						Black cherry	---	---	
Oshtemo	4R	Moderate	Moderate	Slight	Slight	Northern red oak	66	60	Eastern white pine, red pine, white spruce.
						White oak	---	---	
						American basswood	66	60	
						Sugar maple	61	38	
46B	5A	Slight	Slight	Slight	Slight	Northern red oak	75	73	Black walnut, eastern white pine, red pine, white spruce.
Cassopolis						Red maple	75	47	
						White ash	75	73	
						Black walnut	75	73	
						Yellow poplar	---	---	

* Volume is the yield in cubic feet per acre per year calculated at the age of culmination of mean annual increment for fully stocked natural stands.

TABLE 9.--EQUIPMENT LIMITATIONS ON WOODLAND

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitio
"moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Ratings for most limiting season(s)			Preferred operating season(s)	Ratings for preferred ope	
	Logging areas and skid trails	Log Landings	Haul roads		Logging areas and skid trails	Log Landings
2---- Histosols and Aquents	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Winter---	Severe: wetness, low strength.	Severe: wetness, low streng
3A---- Schoolcraft	Slight---	Slight---	Slight---	Year round.	Slight---	Slight-----
3B---- Schoolcraft	Slight---	Slight---	Slight---	Year round.	Slight---	Slight-----
4A---- Oshtemo	Slight---	Slight---	Slight---	Year round.	Slight---	Slight-----
4B---- Oshtemo	Slight---	Slight---	Slight---	Year round.	Slight---	Slight-----
4C---- Oshtemo	Slight---	Moderate: slope.	Slight---	Year round.	Slight---	Moderate: slope.
4D---- Oshtemo	Moderate: slope.	Severe: slope.	Moderate: slope.	Year round.	Moderate: slope.	Severe: slope.
5B---- Spinks	Slight---	Slight---	Slight---	Year round.	Slight---	Slight-----
5C---- Spinks	Slight---	Moderate: slope.	Slight---	Year round.	Slight---	Moderate: slope.
9A---- Kalamazoo	Slight---	Slight---	Slight---	Year round.	Slight---	Slight-----
9B---- Kalamazoo	Slight---	Slight---	Slight---	Year round.	Slight---	Slight-----
9C---- Kalamazoo	Slight---	Moderate: slope.	Slight---	Year round.	Slight---	Moderate: slope.
9D---- Kalamazoo	Moderate: slope.	Severe: slope.	Moderate: slope.	Year round.	Moderate: slope.	Severe: slope.
11---- Edwards	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Winter---	Moderate: low strength.	Severe: low streng

TABLE 9.--EQUIPMENT LIMITATIONS ON WOODLAND--Continued

Soil name and map symbol	Ratings for most limiting season(s)				Ratings for preferred oper	
	Logging areas and skid trails	Log Landings	Haul roads	Preferred operating season(s)	Logging areas and skid trails	Log Landings
12A---------- Brady	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer, fall, winter.	Slight---------	Slight------
15---------- Glendora	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer, winter.	Slight---------	Slight------
16B---------- Ormas	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight------
16C---------- Ormas	Slight---------	Moderate: slope.	Slight---------	Year round.	Slight---------	Moderate: slope.
18---------- Barry	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer, winter.	Slight---------	Slight------
19---------- Houghton	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Winter---	Moderate: low strength.	Severe: low strengt
20A---------- Bronson	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight------
24---------- Adrian	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Winter---	Moderate: low strength.	Severe: low strengt
26C---------- Riddles	Slight---------	Moderate: slope.	Slight---------	Year round.	Slight---------	Moderate: slope.
26D---------- Riddles	Slight---------	Severe: slope.	Slight---------	Year round.	Slight---------	Severe: slope.
26E---------- Riddles	Moderate: slope.	Severe: slope.	Moderate: slope.	Year round.	Moderate: slope.	Severe: slope.
27A---------- Tedrow	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer, fall, winter.	Slight---------	Slight------
28A---------- Teasdale	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer, fall, winter.	Slight---------	Slight------
29---------- Palms	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Winter---	Moderate: low strength.	Severe: low strengt

TABLE 9.--EQUIPMENT LIMITATIONS ON WOODLAND--Continued

Soil name and map symbol	Ratings for most limiting season(s)			Preferred operating season(s)	Ratings for preferred oper	
	Logging areas and skid trails	Log Landings	Haul roads		Logging areas and skid trails	Log Landings
30A---------- Elston	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight------
30B---------- Elston	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight------
36---------- Gilford	Severe: wetness.	Severe: wetness.	Severe: wetness.	Winter, summer.	Slight---------	Slight------
37B---------- Brems	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight------
38---------- Napoleon	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Winter---	Moderate: low strength.	Severe: low strengt
39---------- Cohoctah	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer, winter.	Slight---------	Slight------
40B---------- Coloma	Slight---------	Slight---------	Slight---------	Spring, fall, winter.	Slight---------	Slight------
40C---------- Coloma	Slight---------	Moderate: slope.	Slight---------	Spring, fall, winter.	Slight---------	Moderate: slope.
41B:						
Spinks----------	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight------
Oshtemo----------	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight------
41C:						
Spinks----------	Slight---------	Moderate: slope.	Slight---------	Year round.	Slight---------	Moderate: slope.
Oshtemo----------	Slight---------	Moderate: slope.	Slight---------	Year round.	Slight---------	Moderate: slope.
41D:						
Spinks----------	Moderate: slope.	Severe: slope.	Moderate: slope.	Year round.	Moderate: slope.	Severe: slope.
Oshtemo----------	Moderate: slope.	Severe: slope.	Moderate: slope.	Year round.	Moderate: slope.	Severe: slope.

TABLE 9.--EQUIPMENT LIMITATIONS ON WOODLAND--Continued

Soil name and map symbol	Ratings for most limiting season(s)				Ratings for preferred oper	
	Logging areas and skid trails	Log Landings	Haul roads	Preferred operating season(s)	Logging areas and skid trails	Log Landings
41E:						
Spinks	Moderate: slope.	Severe: slope.	Moderate: slope.	Year round.	Moderate: slope.	Severe: slope.
Oshtemo	Moderate: slope.	Severe: slope.	Moderate: slope.	Year round.	Moderate: slope.	Severe: slope.
46B---------- Cassopolis	Slight----------	Slight----------	Slight----------	Year round.	Slight----------	Slight------

TABLE 10.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--			
	8-15	16-25	26-35	>35
2: Histosols. Aquents.				
3A, 3B---------- Schoolcraft	Lilac, Amur privet, northern whitecedar, American cranberrybush, nannyberry viburnum, silky dogwood.	---	Red pine, white spruce, Norway spruce, green ash, eastern white pine.	Imperial Carolina poplar.
4A, 4B, 4C, 4D---- Oshtemo	Eastern redcedar, lilac, Siberian peashrub, silky dogwood, American cranberrybush, nannyberry viburnum.	---	Eastern white pine, red pine, Norway spruce, jack pine, green ash.	Imperial Carolina poplar.
5B, 5C---------- Spinks	American cranberrybush, silky dogwood, eastern redcedar, lilac, Siberian peashrub.	White spruce----------	Eastern white pine, Norway spruce, red pine, jack pine.	Imperial Carolina poplar.
9A, 9B, 9C, 9D---- Kalamazoo	Lilac, American cranberrybush, Siberian peashrub, silky dogwood, nannyberry viburnum, eastern redcedar.	---	Eastern white pine, Norway spruce, red pine, jack pine, green ash.	Imperial Carolina poplar.
11---------- Edwards	Amur privet, nannyberry viburnum, American cranberrybush, silky dogwood, common ninebark, Amur maple.	Manchurian crabapple, northern whitecedar.	White spruce, green ash, black willow.	---
12A---------- Brady	Silky dogwood, lilac, nannyberry viburnum, Amur maple, American cranberrybush.	Northern whitecedar---	White spruce, Norway spruce, eastern white pine, red pine, green ash.	Imperial Carolina poplar.
15. Glendora				
16B, 16C---------- Ormas	Lilac, silky dogwood, eastern redcedar, American cranberrybush, Siberian peashrub.	Red pine, jack pine, white spruce.	Eastern white pine, Norway spruce.	Imperial Carolina poplar.
18---------- Barry	Silky dogwood, American cranberrybush, Amur privet.	Manchurian crabapple, northern whitecedar.	Norway spruce, green ash, white spruce, white ash, red maple.	---

TABLE 10.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--			
	8-15	16-25	26-35	>35
19---------- Houghton	Silky dogwood, lilac, Amur privet, common ninebark, nannyberry viburnum.	Japanese tree lilac, northern whitecedar.	Black willow, green ash, Siberian crabapple, eastern white pine.	---
20A---------- Bronson	Amur privet, silky dogwood, lilac, common ninebark, Siberian crabapple, nannyberry viburnum.	White spruce----------	Eastern white pine, red pine, Norway spruce, green ash.	Imperial Carolina poplar.
24---------- Adrian	Silky dogwood, common ninebark, Amur privet, American cranberrybush, late lilac, Japanese tree lilac, nannyberry viburnum.	Northern whitecedar---	Eastern white pine, Siberian crabapple, green ash.	---
26C, 26D, 26E----- Riddles	Silky dogwood, Siberian peashrub, lilac, Amur maple.	Northern whitecedar, Siberian crabapple, white spruce.	Green ash, Norway spruce, jack pine, red pine, eastern white pine.	Imperial Carolina poplar.
27A---------- Tedrow	Gray dogwood, common ninebark, American cranberrybush, silky dogwood, Amur privet.	Northern whitecedar, Manchurian crabapple, white spruce.	Eastern white pine, Norway spruce, green ash.	Imperial Carolina poplar.
28A---------- Teasdale	American cranberrybush, Amur privet, silky dogwood, nannyberry viburnum.	Northern whitecedar, Manchurian crabapple, white spruce.	Eastern white pine, green ash, Norway spruce.	Imperial Carolina poplar.
29---------- Palms	Silky dogwood, common ninebark, nannyberry viburnum.	Northern whitecedar, Manchurian crabapple, white spruce.	Eastern white pine, Norway spruce, green ash.	---
30A, 30B---------- Elston	Lilac, Amur privet, Siberian peashrub.	Eastern redcedar, Manchurian crabapple.	Eastern white pine, Norway spruce, red pine.	Imperial Carolina poplar.
34. Pits				
36---------- Gilford	Amur privet, northern whitecedar.	Norway spruce, green ash, golden willow, Manchurian crabapple, white spruce.	Eastern white pine----	---
37B---------- Brems	Eastern redcedar, Amur maple, Siberian peashrub, silky dogwood.	Lilac----------	Eastern white pine, jack pine, Siberian crabapple, green ash, red pine, Norway spruce.	Imperial Carolina poplar.
38. Napoleon				

TABLE 10.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--			
	8-15	16-25	26-35	>35
39---------- Cohoctah	Common ninebark, American cranberrybush, Amur privet, nannyberry viburnum, silky dogwood.	Manchurian crabapple, white spruce, Washington hawthorn, northern whitecedar.	Red maple, eastern white pine, Norway spruce.	Imperial Carolina poplar.
40B, 40C---------- Coloma	Eastern redcedar, Siberian peashrub, lilac, American cranberrybush, silky dogwood, gray dogwood, Amur maple.	---	Eastern white pine, red pine, jack pine, Norway spruce.	Imperial Carolina poplar.
41B, 41C, 41D, 41E:				
Spinks----------	American cranberrybush, silky dogwood, eastern redcedar, lilac, Siberian peashrub.	White spruce----------	Eastern white pine, Norway spruce, red pine, jack pine.	Imperial Carolina poplar.
Oshtemo----------	Eastern redcedar, lilac, Siberian peashrub, silky dogwood, American cranberrybush, nannyberry viburnum.	Jack pine, white spruce.	Eastern white pine, red pine, Norway spruce, green ash.	Imperial Carolina poplar.
42:				
Udipsamments.				
Udorthents.				
44B:				
Urban land.				
Spinks----------	American cranberrybush, silky dogwood, eastern redcedar, lilac, Siberian peashrub.	Red pine, white spruce, jack pine.	Eastern white pine, Norway spruce.	Imperial Carolina poplar.
45B:				
Urban land.				
Kalamazoo--------	Lilac, American cranberrybush, Siberian peashrub, silky dogwood, nannyberry viburnum, eastern redcedar.	Red pine, jack pine, white spruce.	Eastern white pine, Norway spruce, green ash.	Imperial Carolina poplar.
46B---------- Cassopolis	Silky dogwood, Siberian peashrub, lilac, Amur maple.	Northern whitecedar, Siberian crabapple.	Green ash, Norway spruce, jack pine, red pine, eastern white pine.	Imperial Carolina poplar.

TABLE 11.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
2: Histosols. Aquents.				
3A Schoolcraft	Slight	Slight	Slight	Slight.
3B Schoolcraft	Slight	Slight	Moderate: slope.	Slight.
4A Oshtemo	Slight	Slight	Moderate: small stones.	Slight.
4B Oshtemo	Slight	Slight	Moderate: slope, small stones.	Slight.
4C Oshtemo	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
4D Oshtemo	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
5B Spinks	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
5C Spinks	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
9A, 9B Kalamazoo	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Slight.
9C Kalamazoo	Moderate: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones.	Slight.
9D Kalamazoo	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: slope.
11 Edwards	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
12A Brady	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
15 Glendora	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.
16B Ormas	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
16C Ormas	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
18 Barry	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
19 Houghton	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
20A Bronson	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
24 Adrian	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
26C Riddles	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
26D Riddles	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
26E Riddles	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
27A Tedrow	Severe: wetness.	Moderate: wetness, too sandy.	Severe: wetness.	Moderate: wetness, too sandy.
28A Teasdale	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
29 Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
30A Elston	Slight	Slight	Slight	Slight.
30B Elston	Slight	Slight	Moderate: slope.	Slight.
34. Pits				
36 Gilford	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
37B Brems	Moderate: wetness, too sandy.	Moderate: wetness, too sandy.	Moderate: slope, small stones, too sandy.	Moderate: too sandy.
38 Napoleon	Severe: ponding, excess humus, too acid.	Severe: ponding, excess humus, too acid.	Severe: excess humus, ponding, too acid.	Severe: ponding, excess humus.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
39--Cohoctah	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.
40B--Coloma	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, small stones, too sandy.	Moderate: too sandy.
40C--Coloma	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
41B:				
Spinks	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
Oshtemo	Slight	Slight	Moderate: slope, small stones.	Slight.
41C:				
Spinks	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
Oshtemo	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
41D:				
Spinks	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope, too sandy.
Oshtemo	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
41E:				
Spinks	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Oshtemo	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
42:				
Udipsamments.				
Udorthents.				
44B:				
Urban land.				
Spinks	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
45B:				
Urban land.				

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
45B: Kalamazoo	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Slight.
46B Cassopolis	Slight	Slight	Moderate: slope, small stones.	Slight.

TABLE 12.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
2: Histosols. Aquents.										
3A, 3B---------- Schoolcraft	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
4A, 4B---------- Oshtemo	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
4C---------- Oshtemo	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
4D---------- Oshtemo	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
5B---------- Spinks	Fair	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
5C---------- Spinks	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
9A, 9B---------- Kalamazoo	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
9C, 9D---------- Kalamazoo	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
11---------- Edwards	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
12A---------- Brady	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
15---------- Glendora	Very poor.	Very poor.	Fair	Fair	Fair	Good	Good	Very poor.	Fair	Good.
16B, 16C---------- Ormas	Fair	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
18---------- Barry	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
19---------- Houghton	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
20A---------- Bronson	Fair	Fair	Good	Good	Good	Poor	Poor	Fair	Good	Poor.
24---------- Adrian	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
26C---------- Riddles	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

TABLE 12.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
26D---------- Riddles	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
26E---------- Riddles	Very poor.	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
27A---------- Tedrow	Poor	Fair	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
28A---------- Teasdale	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
29---------- Palms	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
30A, 30B---------- Elston	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
34. Pits										
36---------- Gilford	Fair	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
37B---------- Brems	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Fair	Poor	Poor.
38---------- Napoleon	Very poor.	Very poor.	Poor	Poor	Poor	Good	Good	Very poor.	Poor	Good.
39---------- Cohoctah	Poor	Poor	Poor	Good	Good	Good	Good	Poor	Good	Good.
40B---------- Coloma	Fair	Fair	Fair	Fair	Good	Very poor.	Very poor.	Fair	Fair	Very poor.
40C---------- Coloma	Poor	Fair	Fair	Fair	Good	Very poor.	Very poor.	Fair	Fair	Very poor.
41B: Spinks----------	Fair	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
Oshtemo----------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
41C: Spinks----------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Oshtemo----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
41D: Spinks----------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Oshtemo----------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.

TABLE 12.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
41E:										
Spinks	Very poor.	Poor	Good	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
Oshtemo	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
42:										
Udipsamments.										
Udorthents.										
44B:										
Urban land.										
Spinks	Fair	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
45B:										
Urban land.										
Kalamazoo	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
46B Cassopolis	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

TABLE 13.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
2: Histosols.						
Aquents.						
3A, 3B---------- Schoolcraft	Severe: cutbanks cave.	Moderate: shrink-swell.	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell, low strength.	Slight.
4A---------- Oshtemo	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
4B---------- Oshtemo	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Slight.
4C---------- Oshtemo	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
4D---------- Oshtemo	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
5B---------- Spinks	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
5C---------- Spinks	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
9A---------- Kalamazoo	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, low strength.	Moderate: small stones.
9B---------- Kalamazoo	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.	Moderate: small stones.
9C---------- Kalamazoo	Severe: cutbanks cave.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: shrink-swell, low strength, slope.	Moderate: small stones, slope.
9D---------- Kalamazoo	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
11---------- Edwards	Severe: ponding, excess humus.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: excess humus, ponding.
12A---------- Brady	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.

TABLE 13.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
15--- Glendora	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.
16B--- Ormas	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Moderate: frost action.	Moderate: droughty.
16C--- Ormas	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: droughty, slope.
18--- Barry	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
19--- Houghton	Severe: ponding, excess humus.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: excess humus, ponding.
20A--- Bronson	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
24--- Adrian	Severe: cutbanks cave, excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
26C--- Riddles	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: shrink-swell, low strength, slope.	Moderate: slope.
26D, 26E--- Riddles	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
27A--- Tedrow	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.	Moderate: wetness, droughty.
28A--- Teasdale	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
29--- Palms	Severe: excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding.	Severe: subsides, ponding, low strength.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.
30A--- Elston	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Slight---	Slight.
30B--- Elston	Severe: cutbanks cave.	Slight---	Slight---	Moderate: slope.	Slight---	Slight.
34. Pits						

TABLE 13.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
36---- Gilford	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
37B---- Brems	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: droughty.
38---- Napoleon	Severe: excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: too acid, ponding, excess humus.
39---- Cohoctah	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding, frost action.	Severe: wetness, flooding.
40B---- Coloma	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight----------	Moderate: large stones, droughty.
40C---- Coloma	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: large stones, droughty, slope.
41B:						
Spinks----------	Severe: cutbanks cave.	Slight----------	Slight----------	Moderate: slope.	Slight----------	Moderate: droughty.
Oshtemo----------	Severe: cutbanks cave.	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
41C:						
Spinks----------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Oshtemo----------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
41D, 41E:						
Spinks----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Oshtemo----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
42:						
Udipsamments.						
Udorthents.						
44B:						
Urban land.						
Spinks----------	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight----------	Moderate: droughty.

TABLE 13.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
45B: Urban land.						
Kalamazoo	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, low strength.	Moderate: small stones.
46B Cassopolis	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength, frost action.	Slight.

TABLE 14.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "poor," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
2: Histosols. Aquents.					
3A, 3B Schoolcraft	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
4A, 4B Oshtemo	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
4C Oshtemo	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: seepage.
4D Oshtemo	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: seepage, slope.
5B Spinks	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
5C Spinks	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
9A, 9B Kalamazoo	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: thin layer.
9C Kalamazoo	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: thin layer.
9D Kalamazoo	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope, thin layer.
11 Edwards	Severe: subsides, ponding, percs slowly.	Severe: ponding, seepage, excess humus.	Severe: ponding.	Severe: ponding, seepage.	Poor: ponding, excess humus.
12A Brady	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: wetness, thin layer.
15 Glendora	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy, wetness.
16B Ormas	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: thin layer.

TABLE 14.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
16C---------- Ormas	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: thin layer.
18---------- Barry	Severe: ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding.
19---------- Houghton	Severe: subsides, ponding, percs slowly.	Severe: seepage, ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
20A---------- Bronson	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: thin layer.
24---------- Adrian	Severe: subsides, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
26C---------- Riddles	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
26D, 26E---------- Riddles	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
27A---------- Tedrow	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
28A---------- Teasdale	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness.	Poor: wetness.
29---------- Palms	Severe: subsides, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding.	Severe: ponding, seepage.	Poor: ponding.
30A, 30B---------- Elston	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
34. Pits					
36---------- Gilford	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding, thin layer.
37B---------- Brems	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.

TABLE 14.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
38--Napoleon	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus, too acid.
39--Cohoctah	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: wetness, thin layer.
40B--Coloma	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
40C--Coloma	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
41B:					
Spinks	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Oshtemo	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
41C:					
Spinks	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Oshtemo	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: seepage.
41D, 41E:					
Spinks	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
Oshtemo	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: seepage, slope.
42:					
Udipsamments.					
Udorthents.					
44B:					
Urban land.					
Spinks	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
45B:					
Urban land.					

TABLE 14.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
45B:					
Kalamazoo	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: thin layer.
46B					
Cassopolis	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.

TABLE 15.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
2: Histosols. Aquents.				
3A, 3B Schoolcraft	Good	Probable	Improbable: too sandy.	Fair: small stones, area reclaim.
4A, 4B, 4C Oshtemo	Good	Probable	Probable	Poor: small stones.
4D Oshtemo	Fair: slope.	Probable	Probable	Poor: small stones, slope.
5B Spinks	Good	Probable	Improbable: too sandy.	Fair: too sandy.
5C Spinks	Good	Probable	Improbable: too sandy.	Fair: slope, too sandy.
9A, 9B, 9C Kalamazoo	Good	Probable	Probable	Poor: small stones, area reclaim.
9D Kalamazoo	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
11 Edwards	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: wetness, excess humus.
12A Brady	Fair: wetness.	Probable	Probable	Poor: small stones.
15 Glendora	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
16B Ormas	Good	Probable	Probable	Fair: too sandy, small stones.
16C Ormas	Good	Probable	Probable	Fair: too sandy, small stones.
18 Barry	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.

TABLE 15.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
19--Houghton	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: wetness, excess humus.
20A--Bronson	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim.
24--Adrian	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.
26C--Riddles	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
26D--Riddles	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
26E--Riddles	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
27A--Tedrow	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
28A--Teasdale	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
29--Palms	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess humus.
30A, 30B--Elston	Good	Probable	Improbable: too sandy.	Fair: small stones, area reclaim.
34. Pits				
36--Gilford	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
37B--Brems	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
38--Napoleon	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness, too acid.
39--Cohoctah	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
40B, 40C--Coloma	Good	Probable	Improbable: too sandy.	Poor: too sandy, small stones.
41B: Spinks	Good	Probable	Improbable: too sandy.	Fair: too sandy.

TABLE 15.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
41B:				
Oshtemo	Good	Probable	Probable	Poor: small stones.
41C:				
Spinks	Good	Probable	Improbable: too sandy.	Fair: slope, too sandy.
Oshtemo	Good	Probable	Probable	Poor: small stones.
41D:				
Spinks	Fair: slope.	Probable	Improbable: too sandy.	Poor: slope.
Oshtemo	Fair: slope.	Probable	Probable	Poor: small stones, slope.
41E:				
Spinks	Poor: slope.	Probable	Improbable: too sandy.	Poor: slope.
Oshtemo	Poor: slope.	Probable	Probable	Poor: small stones, slope.
42:				
Udipsamments.				
Udorthents.				
44B:				
Urban land.				
Spinks	Good	Probable	Improbable: too sandy.	Fair: too sandy.
45B:				
Urban land.				
Kalamazoo	Good	Probable	Probable	Poor: small stones, area reclaim.
46B Cassopolis	Fair: shrink-swell, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.

TABLE 16.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "moderate" and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
2: Histosols. Aquents.						
3A---Schoolcraft	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Favorable	Favorable.
3B---Schoolcraft	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope	Favorable.
4A---Oshtemo	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Soil blowing	Favorable.
4B---Oshtemo	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, soil blowing.	Favorable.
4C, 4D---Oshtemo	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, soil blowing.	Slope.
5B---Spinks	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Droughty.
5C---Spinks	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, droughty.
9A---Kalamazoo	Severe: seepage.	Severe: thin layer.	Severe: no water.	Deep to water	Favorable	Favorable.
9B---Kalamazoo	Severe: seepage.	Severe: thin layer.	Severe: no water.	Deep to water	Slope	Favorable.
9C, 9D---Kalamazoo	Severe: seepage, slope.	Severe: thin layer.	Severe: no water.	Deep to water	Slope	Slope.
11---Edwards	Severe: seepage.	Severe: ponding, excess humus.	Severe: slow refill.	Frost action, ponding, subsides.	Ponding, soil blowing.	Wetness.
12A---Brady	Severe: seepage.	Severe: piping, wetness.	Severe: cutbanks cave.	Frost action	Wetness	Wetness.
15---Glendora	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Flooding, cutbanks cave.	Wetness, droughty.	Wetness, droughty.

TABLE 16.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
16B---------- Ormas	Severe: seepage.	Severe: thin layer.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Droughty.
16C---------- Ormas	Severe: seepage, slope.	Severe: thin layer.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, droughty.
18---------- Barry	Severe: seepage.	Severe: thin layer, ponding.	Moderate: slow refill.	Ponding, frost action.	Ponding--------	Wetness.
19---------- Houghton	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Frost action, subsides, ponding.	Ponding, soil blowing.	Wetness.
20A---------- Bronson	Severe: seepage.	Severe: thin layer.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, fast intake, soil blowing.	Favorable.
24---------- Adrian	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: slow refill, cutbanks cave.	Ponding, subsides, frost action.	Ponding, soil blowing, rooting depth.	Wetness, rooting depth.
26C, 26D, 26E----- Riddles	Severe: slope.	Moderate: thin layer, piping.	Severe: no water.	Deep to water	Slope, soil blowing.	Slope.
27A---------- Tedrow	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty.	Wetness, droughty.
28A---------- Teasdale	Severe: seepage.	Severe: wetness.	Severe: cutbanks cave.	Frost action---	Wetness, soil blowing.	Wetness, rooting depth.
29---------- Palms	Severe: seepage.	Severe: piping, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness, rooting depth.
30A---------- Elston	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Soil blowing---	Favorable.
30B---------- Elston	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, soil blowing.	Favorable.
34. Pits						
36---------- Gilford	Severe: seepage.	Severe: piping, ponding.	Severe: cutbanks cave.	Ponding, frost action, cutbanks cave.	Ponding, soil blowing.	Wetness.
37B---------- Brems	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Slope, cutbanks cave.	Slope, wetness, droughty.	Droughty.

TABLE 16.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
38---------- Napoleon	Severe: seepage.	Severe: excess humus, ponding.	Moderate: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing, too acid.	Wetness.
39---------- Cohoctah	Severe: seepage.	Severe: piping, wetness.	Severe: cutbanks cave.	Flooding, frost action.	Wetness, soil blowing, flooding.	Wetness.
40B---------- Coloma	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Droughty.
40C---------- Coloma	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, droughty.
41B:						
Spinks----------	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Droughty.
Oshtemo----------	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, soil blowing.	Favorable.
41C, 41D, 41E:						
Spinks----------	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, droughty.
Oshtemo----------	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, soil blowing.	Slope.
42:						
Udipsamments.						
Udorthents.						
44B:						
Urban land.						
Spinks----------	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Droughty.
45B:						
Urban land.						
Kalamazoo--------	Severe: seepage.	Severe: thin layer.	Severe: no water.	Deep to water	Slope----------	Favorable.
46B---------- Cassopolis	Moderate: seepage, slope.	Moderate: thin layer, piping, wetness.	Moderate: deep to water, slow refill.	Slope----------	Slope, wetness, soil blowing.	Favorable.

TABLE 17.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
2:											
Histosols.											
Aquents.											
3A, 3B----------	0-11	Loam----------	CL-ML, CL	A-4	0	95-100	85-100	70-95	50-75	20-30	5-10
Schoolcraft	11-29	Clay loam, sandy clay loam.	CL, SC	A-6, A-7	0	90-100	85-100	70-95	35-75	25-45	10-20
	29-33	Sandy loam-------	SM-SC, SC	A-2, A-4	0	90-100	85-100	50-70	25-40	20-30	5-10
	33-63	Sand, gravelly sand.	SP, SP-SM	A-1, A-2, A-3	0	75-100	70-95	35-65	0-10	---	NP
4A, 4B, 4C, 4D---	0-11	Sandy loam-------	SM, SM-SC, ML, CL-ML	A-2, A-4	0	95-100	85-95	50-85	25-55	<20	NP-4
Oshtemo	11-35	Sandy loam, sandy clay loam, gravelly sandy loam.	SC, SM-SC	A-2, A-4, A-1	0	80-100	55-95	35-85	15-50	20-30	4-10
	35-60	Loamy sand, sand, gravelly sand.	SM, SP-SM	A-2, A-1	0	80-95	55-95	35-70	10-35	---	NP
5B, 5C----------	0-10	Loamy sand-------	SM, SM-SC, SP-SM	A-2-4, A-1-b	0	95-100	80-100	35-90	10-30	<25	NP-7
Spinks	10-53	Loamy sand, sand, loamy fine sand.	SM, SP-SM, SM-SC	A-2-4, A-3, A-1-b	0	95-100	80-100	35-90	5-35	<25	NP-7
	53-60	Fine sand, sand	SP-SM, SM	A-2-4, A-3, A-1-b	0	95-100	80-100	35-90	5-35	<20	NP-4
9A, 9B, 9C, 9D---	0-9	Loam----------	ML, CL-ML, CL	A-4, A-6	0-5	95-100	70-100	65-90	50-70	<35	NP-15
Kalamazoo	9-30	Clay loam, sandy clay loam, gravelly sandy clay loam.	SC, CL	A-4, A-6, A-7, A-2	0-5	80-100	70-95	40-95	24-80	25-45	7-25
	30-42	Sand, loamy sand, gravelly loamy sand.	SM, SP-SM, SM-SC	A-2-4, A-1-b	0-5	80-100	60-95	30-70	10-30	<25	NP-7
	42-60	Sand, gravelly sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	40-100	25-100	10-70	0-15	---	NP
11----------	0-22	Muck----------	PT	A-8	0	---	---	---	---	---	---
Edwards	22-60	Marl----------	---	---	0	100	95-100	80-90	60-80	---	---
12A----------	0-9	Sandy loam-------	SM, SM-SC, ML, CL-ML	A-2, A-4, A-1	0-5	95-100	75-100	45-85	20-55	<25	NP-7
Brady	9-29	Sandy loam, sandy clay loam, gravelly sandy loam.	SM, SC, ML, CL	A-2, A-4, A-6, A-1	0-5	85-100	60-100	35-90	20-55	15-35	NP-15
	29-48	Loamy sand, sandy loam.	SM, SC, SP-SM, SM-SC	A-2, A-4, A-1	0-5	95-100	75-100	35-70	10-40	<30	NP-10
	48-60	Gravelly sand, sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2-4	0-5	40-95	30-85	20-60	0-10	---	NP

TABLE 17.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
15----------	0-6	Muck----------	PT	A-8	0	---	---	---	---	---	---
Glendora	6-9	Mucky sandy loam	SM, SM-SC	A-4, A-2-4	0-5	95-100	90-100	55-70	25-40	<25	2-7
	9-60	Stratified sand to loamy fine sand.	SP, SM, SP-SM	A-3, A-2-4, A-1-b	0-5	95-100	90-100	45-85	0-35	---	NP
16B, 16C----------	0-9	Loamy sand-------	SM	A-2-4	0	95-100	95-100	50-75	15-30	---	NP
Ormas	9-24	Sand, loamy sand	SW-SM, SM, SP-SM	A-2-4, A-1-b	0	95-100	90-100	45-70	10-20	---	NP
	24-41	Sandy loam, fine sandy loam.	SM-SC, SM, SC	A-2-4	0	90-100	95-100	50-70	25-40	15-30	NP-5
	41-60	Gravelly loamy sand, gravelly sandy loam, gravelly fine sandy loam.	SP, SP-SM, GP, GP-GM	A-3, A-1-b, A-2-4	0-3	35-80	30-80	30-55	3-12	---	NP
18----------	0-8	Loam----------	ML, CL, CL-ML	A-4	0-3	90-100	75-100	70-100	55-90	20-30	NP-10
Barry	8-40	Silt loam, sandy clay loam, sandy loam.	SC, CL	A-6, A-2-6	0-3	90-100	75-100	45-95	20-75	25-35	10-15
	40-60	Sandy loam, loamy sand.	SM, SC, SP-SM, SM-SC	A-4, A-2, A-1	0-3	90-100	75-100	35-70	10-40	<30	NP-10
19----------	0-15	Muck----------	PT	A-8	0	---	---	---	---	---	---
Houghton	15-60	Sapric material	PT	A-8	0	---	---	---	---	---	---
20A----------	0-18	Loamy sand-------	SM, SP-SM, SM-SC	A-2, A-1	0-5	95-100	90-100	45-75	10-30	<25	NP-7
Bronson	18-47	Sandy loam, sandy clay loam.	SM, SM-SC, ML, CL-ML	A-2, A-4	0-5	95-100	75-95	50-80	35-65	20-30	4-11
	47-62	Loamy sand, sand	SM, SP, SP-SM	A-2, A-3	0-5	75-100	75-100	50-75	2-30	<20	NP-4
24----------	0-20	Muck----------	PT	A-8	---	---	---	---	---	---	---
Adrian	20-60	Sand, fine sand, gravelly sand.	SP, SM	A-2, A-3, A-1	0	80-100	60-100	30-80	0-35	---	NP
26C, 26D, 26E----	0-7	Fine sandy loam	SM, SM-SC	A-4	0-3	90-100	75-95	45-85	35-50	<25	NP-7
Riddles	7-34	Clay loam, loam, sandy loam.	CL, SC	A-6	0-3	90-100	75-95	45-90	45-90	25-40	10-20
	34-60	Sandy loam, loam	SM, SM-SC, CL-ML, ML	A-4	0-3	85-95	75-90	45-90	40-90	<20	NP-7
27A----------	0-9	Loamy sand-------	SM	A-2	0	100	95-100	60-80	20-35	---	NP
Tedrow	9-34	Loamy fine sand, loamy sand, sand.	SM, SP-SM	A-2, A-3	0	100	95-100	60-80	5-35	---	NP
	34-60	Sand, fine sand	SM, SP, SP-SM	A-2, A-3	0	100	95-100	50-70	3-35	---	NP

TABLE 17.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
28A--- Teasdale	0-9	Fine sandy loam	SM, SC, ML, CL	A-2-4, A-4	0-5	90-100	85-100	50-85	25-55	<25	2-8
	9-48	Sandy loam, fine sandy loam, loam.	CL, SC, CL-ML, SM-SC	A-2-6, A-6, A-2-4, A-4	0-3	95-100	95-100	40-80	25-75	20-30	5-15
	48-60	Sandy loam, fine sandy loam.	SM, SM-SC	A-2-4	0-3	95-100	95-100	55-80	15-55	<25	NP-8
29--- Palms	0-12	Muck---	PT	A-8	0	---	---	---	---	---	---
	12-26	Sapric material, muck.	PT	A-8	---	---	---	---	---	---	---
	26-60	Sandy loam, fine sandy loam, loamy sand.	SM, ML, SC, SM-SC	A-4, A-2-4, A-1-b	0	85-100	60-100	35-95	15-55	<25	NP-8
30A, 30B--- Elston	0-14	Sandy loam---	SM, SM-SC, ML, CL-ML	A-2, A-4	0	100	100	60-85	30-55	<20	NP-5
	14-27	Sandy loam, loam, sandy clay loam.	SM, SM-SC, ML, CL-ML	A-4	0	95-100	75-95	50-80	35-65	<25	NP-7
	27-41	Loamy sand, sandy loam.	SP-SM, SM	A-2-4, A-3, A-1-b	0-3	95-100	75-95	45-75	5-30	<20	NP
	41-60	Sand---	SP-SM, SM, SP	A-3, A-2, A-1	0-3	95-100	75-100	40-70	0-15	---	NP
34. Pits											
36--- Gilford	0-10	Sandy loam---	SM, SC, SM-SC	A-4, A-2-4	0	95-100	95-100	60-80	30-45	<25	2-10
	10-22	Sandy loam, fine sandy loam.	SM, SC, SM-SC	A-2-4	0	95-100	95-100	55-70	20-35	15-30	NP-8
	22-28	Loamy sand, sand	SM, SP, SP-SM	A-3, A-1-b, A-2-4	0	95-100	95-100	15-60	3-20	---	NP
	28-60	Sand, loamy sand	SP, SP-SM, SM	A-1-b, A-2-4, A-3	0	95-100	95-100	15-60	3-20	---	NP
37B--- Brems	0-9	Loamy sand---	SM, SP-SM	A-2-4	0	100	85-100	50-85	10-30	---	NP
	9-60	Sand, fine sand, loamy sand.	SM, SP-SM	A-3, A-2-4	0	100	80-100	50-85	5-25	---	NP
38--- Napoleon	0-8	Muck---	PT	A-8	0	---	---	---	---	---	---
	8-60	Mucky peat---	PT	A-8	0	---	---	---	---	---	---
39--- Cohoctah	0-11	Loam---	ML, CL, CL-ML	A-4, A-6	0	100	90-100	75-95	55-70	<30	NP-11
	11-25	Sandy loam, loam, fine sandy loam.	SM, SM-SC, ML, CL-ML	A-2-4, A-4	0	100	90-100	55-90	30-70	<20	NP-6
	25-60	Sand, fine sand	SP, SP-SM, SM	A-3, A-2-4, A-1-b	0	100	70-95	35-90	5-35	<20	NP-4

TABLE 17.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
40B, 40C--------- Coloma	0-10	Loamy sand--------	SM	A-2, A-4	0-8	75-100	75-100	50-90	15-50	---	NP
	10-34	Sand, loamy sand	SP, SM, SP-SM	A-2, A-3	0-8	75-100	75-100	50-75	2-30	---	NP
	34-60	Stratified sand to sandy loam.	SP, SM, SP-SM	A-2, A-3, A-4	0-8	75-100	75-100	50-100	2-40	---	NP
41B, 41C, 41D, 41E: Spinks----------	0-10	Loamy sand--------	SM, SM-SC, SP-SM	A-2-4, A-1-b	0	95-100	80-100	35-90	10-30	<25	NP-7
	10-53	Loamy sand, sand, loamy fine sand.	SM, SP-SM, SM-SC	A-2-4, A-3, A-1-b	0	95-100	80-100	35-90	5-35	<25	NP-7
	53-60	Fine sand, sand	SP-SM, SM	A-2-4, A-3, A-1-b	0	95-100	80-100	35-90	5-35	<20	NP-4
Oshtemo---------	0-11	Sandy loam--------	SM, SM-SC, ML, CL-ML	A-2, A-4	0	95-100	85-95	50-85	25-55	<20	NP-4
	11-35	Sandy loam, sandy clay loam, gravelly sandy loam.	SC, SM-SC	A-2, A-4, A-1	0	80-100	55-95	35-85	15-50	20-30	4-10
	35-60	Loamy sand, sandy loam, gravelly loamy sand.	SM, SP-SM	A-2, A-1	0	80-95	55-95	35-70	10-35	---	NP
42: Udipsamments.											
Udorthents.											
44B: Urban land.											
Spinks----------	0-10	Loamy sand--------	SM, SM-SC, SP-SM	A-2-4, A-1-b	0	95-100	80-100	35-90	10-30	<25	NP-7
	10-53	Loamy sand, sand, loamy fine sand.	SM, SP-SM, SM-SC	A-2-4, A-3, A-1-b	0	95-100	80-100	35-90	5-35	<25	NP-7
	53-60	Fine sand, sand	SP-SM, SM	A-2-4, A-3, A-1-b	0	95-100	80-100	35-90	5-35	<20	NP-4
45B: Urban land.											
Kalamazoo--------	0-9	Loam-------------	ML, CL-ML, CL	A-4, A-6	0-5	95-100	70-100	65-90	50-70	<35	NP-15
	9-30	Clay loam, sandy clay loam, gravelly sandy clay loam.	SC, CL	A-4, A-6, A-7, A-2	0-5	80-100	70-95	40-95	24-80	25-45	7-25
	30-42	Sand, loamy sand, gravelly loamy sand.	SM, SP-SM, SM-SC	A-2-4, A-1-b	0-5	80-100	60-95	30-70	10-30	<25	NP-7
	42-60	Sand, gravelly sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	40-100	25-100	10-70	0-15	---	NP

TABLE 17.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
46B---------- Cassopolis	0-11	Fine sandy loam	SM, SC, SM-SC	A-2-4, A-4	0	95-100	85-95	50-70	25-40	<25	2-10
	11-61	Sandy clay loam, clay loam, loam.	CL, SC	A-6	0	90-100	80-95	75-90	35-75	25-40	10-20
	61-65	Loam, sandy loam	CL, SM, SC, ML	A-4, A-6, A-2	0-3	85-95	80-90	50-90	30-70	15-30	2-15

TABLE 18.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
2:											
Histosols.											
Aquents.											
3A, 3B----------	0-11	12-20	1.30-1.60	0.6-2.0	0.18-0.22	5.6-7.3	Low----------	0.28	4	5	1-3
Schoolcraft	11-29	18-35	1.40-1.70	0.6-2.0	0.12-0.19	4.5-6.5	Moderate-----	0.28			
	29-33	12-20	1.30-1.70	0.6-2.0	0.10-0.14	4.5-6.5	Low----------	0.20			
	33-63	0-10	1.50-1.60	6.0-20	0.02-0.07	5.6-8.4	Low----------	0.10			
4A, 4B, 4C, 4D---	0-11	2-12	1.35-1.60	2.0-6.0	0.10-0.15	5.1-6.5	Low----------	0.24	5	3	.5-3
Oshtemo	11-35	10-18	1.30-1.60	2.0-6.0	0.12-0.19	5.1-6.5	Low----------	0.24			
	35-60	5-15	1.30-1.60	2.0-6.0	0.06-0.10	5.1-7.3	Low----------	0.17			
5B, 5C----------	0-10	2-15	1.40-1.70	6.0-20	0.08-0.10	5.1-7.3	Low----------	0.17	5	2	2-4
Spinks	10-53	0-15	1.40-1.70	2.0-20	0.05-0.10	5.6-7.3	Low----------	0.17			
	53-60	0-10	1.40-1.70	6.0-20	0.04-0.06	6.6-8.4	Low----------	0.17			
9A, 9B, 9C, 9D---	0-9	8-25	1.30-1.65	0.6-2.0	0.16-0.22	5.1-7.3	Low----------	0.32	4	5	1-3
Kalamazoo	9-30	18-35	1.35-1.70	0.6-2.0	0.10-0.18	5.1-7.3	Moderate-----	0.32			
	30-42	2-15	1.50-1.65	6.0-20	0.02-0.08	5.1-7.8	Low----------	0.15			
	42-60	0-10	1.50-1.65	6.0-20	0.01-0.03	6.1-8.4	Low----------	0.10			
11----------	0-22	---	0.30-0.55	0.2-6.0	0.35-0.45	4.5-7.8	----------	----	4	2	55-75
Edwards	22-60	---	---	---	---	7.4-8.4	----------	----			
12A----------	0-9	2-15	1.35-1.55	2.0-6.0	0.12-0.16	5.1-7.3	Low----------	0.20	5	3	2-4
Brady	9-29	5-22	1.35-1.55	2.0-6.0	0.12-0.17	5.1-6.5	Low----------	0.24			
	29-48	5-20	1.35-1.50	2.0-6.0	0.08-0.13	5.1-7.3	Low----------	0.20			
	48-60	0-10	1.40-1.50	>20	0.02-0.04	6.6-8.4	Low----------	0.10			
15----------	0-6	---	0.30-0.45	0.2-6.0	0.35-0.45	5.6-7.8	----------	----	5	2	>70
Glendora	6-9	8-15	1.00-1.35	2.0-6.0	0.16-0.18	5.6-7.8	Low----------	0.20			
	9-60	0-10	1.40-1.65	6.0-20	0.05-0.11	5.6-7.8	Low----------	0.17			
16B, 16C----------	0-9	5-12	1.40-1.60	6.0-20	0.10-0.12	5.6-7.3	Low----------	0.17	5	2	1-3
Ormas	9-24	3-10	1.45-1.60	6.0-20	0.07-0.09	5.6-6.5	Low----------	0.17			
	24-41	10-18	1.50-1.70	2.0-6.0	0.12-0.14	5.1-6.5	Low----------	0.17			
	41-60	1-15	1.55-1.70	>20	0.03-0.05	6.1-8.4	Low----------	0.15			
18----------	0-8	8-18	1.60-1.70	0.6-2.0	0.20-0.22	6.1-7.8	Low----------	0.28	5	5	4-7
Barry	8-40	18-30	1.60-1.70	0.6-2.0	0.14-0.19	5.6-7.8	Low----------	0.28			
	40-60	5-18	1.60-1.70	2.0-6.0	0.10-0.17	5.6-8.4	Low----------	0.28			
19----------	0-15	---	0.30-0.45	0.2-6.0	0.35-0.45	4.5-7.8	----------	----	5	2	>70
Houghton	15-60	---	0.15-0.30	0.2-6.0	0.35-0.45	4.5-7.8	----------	----			
20A----------	0-18	2-12	1.30-1.60	6.0-20	0.10-0.12	5.1-7.3	Low----------	0.17	4	2	.5-3
Bronson	18-47	10-25	1.35-1.60	2.0-6.0	0.12-0.18	5.1-7.3	Low----------	0.24			
	47-62	0-10	1.35-1.60	6.0-20	0.06-0.08	5.1-7.3	Low----------	0.17			
24----------	0-20	---	0.30-0.55	0.2-6.0	0.35-0.45	5.1-7.3	----------	----	4	2	55-75
Adrian	20-60	2-10	1.40-1.75	6.0-20	0.03-0.08	5.6-8.4	Low----------	----			
26C, 26D, 26E----	0-7	4-14	1.35-1.45	2.0-6.0	0.13-0.18	5.6-7.3	Low----------	0.24	5	3	.5-2
Riddles	7-34	18-30	1.40-1.60	0.6-2.0	0.12-0.18	4.5-7.3	Moderate-----	0.32			
	34-60	8-15	1.45-1.65	0.6-2.0	0.08-0.13	4.5-7.3	Low----------	0.32			

TABLE 18.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
27A	0-9	2-10	1.40-1.60	6.0-20	0.08-0.12	6.1-7.3	Low	0.17	5	2	1-3
Tedrow	9-34	2-8	1.50-1.70	6.0-20	0.07-0.11	5.6-7.8	Low	0.17			
	34-60	1-8	1.50-1.70	6.0-20	0.05-0.07	6.6-8.4	Low	0.17			
28A	0-9	5-15	1.25-1.75	2.0-6.0	0.12-0.15	5.1-7.3	Low	0.24	5	3	2-3
Teasdale	9-48	10-18	1.55-1.75	0.6-2.0	0.11-0.17	4.5-7.3	Low	0.24			
	48-60	5-15	1.60-1.85	2.0-6.0	0.11-0.15	6.6-8.4	Low	0.24			
29	0-12	---	0.30-0.55	0.2-6.0	0.35-0.45	5.1-7.8	---	---	5	2	>75
Palms	12-26	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	---	---			
	26-60	7-18	1.45-1.75	0.2-2.0	0.11-0.16	6.1-8.4	Low	---			
30A, 30B	0-14	8-15	1.35-1.45	2.0-6.0	0.12-0.15	5.1-7.3	Low	0.20	4	3	1-5
Elston	14-27	10-18	1.35-1.60	2.0-6.0	0.12-0.18	5.1-6.0	Low	0.20			
	27-41	4-10	1.45-1.65	6.0-20	0.08-0.13	5.1-6.5	Low	0.20			
	41-60	1-5	1.60-1.75	>20	0.05-0.07	5.6-8.4	Low	0.15			
34. Pits											
36	0-10	10-20	1.50-1.70	2.0-6.0	0.16-0.18	5.6-7.3	Low	0.20	4	3	2-4
Gilford	10-22	8-17	1.60-1.80	2.0-6.0	0.12-0.14	5.6-7.3	Low	0.20			
	22-28	3-12	1.70-1.90	6.0-20	0.05-0.08	6.1-7.3	Low	0.15			
	28-60	2-10	1.70-1.90	6.0-20	0.05-0.08	6.6-8.4	Low	0.15			
37B	0-9	3-7	1.50-1.65	6.0-20	0.10-0.12	5.1-7.3	Low	0.17	5	2	.5-1
Brems	9-60	2-6	1.60-1.75	6.0-20	0.05-0.08	4.5-6.5	Low	0.17			
38	0-8	---	0.30-0.40	0.2-6.0	0.35-0.45	<4.5	---	---	5	2	70-90
Napoleon	8-60	---	0.10-0.20	0.6-6.0	0.45-0.55	<4.5	---	---			
39	0-11	5-15	1.20-1.50	2.0-6.0	0.20-0.22	6.1-7.3	Low	0.20	4	3	2-4
Cohoctah	11-25	5-18	1.55-1.65	2.0-6.0	0.12-0.18	6.1-7.3	Low	0.28			
	25-60	1-6	1.60-1.70	6.0-20	0.05-0.07	6.6-7.8	Low	0.15			
40B, 40C	0-10	2-10	1.35-1.65	6.0-20	0.08-0.12	4.5-7.3	Low	0.17	5	2	<1
Coloma	10-34	0-10	1.35-1.65	6.0-20	0.05-0.12	4.5-6.5	Low	0.15			
	34-60	2-12	1.50-1.65	6.0-20	0.03-0.08	4.5-6.0	Low	0.15			
41B, 41C, 41D, 41E:											
Spinks	0-10	2-15	1.40-1.70	6.0-20	0.08-0.10	5.1-7.3	Low	0.17	5	2	2-4
	10-53	0-15	1.40-1.70	2.0-20	0.05-0.10	5.6-7.3	Low	0.17			
	53-60	0-10	1.40-1.70	6.0-20	0.04-0.06	6.6-8.4	Low	0.17			
Oshtemo	0-11	2-12	1.35-1.60	2.0-6.0	0.10-0.15	5.1-6.5	Low	0.24	5	3	.5-3
	11-35	10-18	1.30-1.60	2.0-6.0	0.12-0.19	5.1-6.5	Low	0.24			
	35-60	5-15	1.30-1.60	2.0-6.0	0.06-0.10	5.1-7.3	Low	0.17			
42:											
Udipsamments.											
Udorthents.											
44B:											
Urban land.											
Spinks	0-10	2-15	1.40-1.70	6.0-20	0.08-0.10	5.1-7.3	Low	0.17	5	2	2-4
	10-53	0-15	1.40-1.70	2.0-20	0.05-0.10	5.6-7.3	Low	0.17			
	53-60	0-10	1.40-1.70	6.0-20	0.04-0.06	6.6-8.4	Low	0.17			

TABLE 18.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
45B:											
Urban land.											
Kalamazoo-------	0-9	8-25	1.30-1.65	0.6-2.0	0.16-0.22	5.1-7.3	Low----------	0.32	4	5	1-3
	9-30	18-35	1.35-1.70	0.6-2.0	0.10-0.18	5.1-7.3	Moderate-----	0.32			
	30-42	2-15	1.50-1.65	6.0-20	0.02-0.08	5.1-7.8	Low----------	0.15			
	42-60	0-10	1.50-1.65	6.0-20	0.01-0.03	7.4-8.4	Low----------	0.10			
46B--------------	0-11	4-14	1.35-1.55	2.0-6.0	0.13-0.15	5.6-7.3	Low----------	0.24	5	3	.5-2
Cassopolis	11-61	20-30	1.40-1.60	0.6-2.0	0.16-0.18	5.6-7.3	Moderate-----	0.32			
	61-65	8-25	1.40-1.60	0.6-2.0	0.05-0.19	5.6-7.3	Low----------	0.32			

TABLE 19.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "frequent," "brief," and "apparent" are explained in the text. means less than; > means more than. Absence of an entry indicates that the feature is not a concern or tha estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Subsidence		Potential frost action	R Un
		Frequency	Duration	Months	Depth	Kind	Months	Initial	Total		
					Ft			In	In		
2: Histosols. Aquents.											
3A, 3B---------- Schoolcraft	B	None--------	---	---	>6.0	---	---	---	---	Moderate	Lo
4A, 4B, 4C, 4D---- Oshtemo	B	None--------	---	---	>6.0	---	---	---	---	Low------	Lo
5B, 5C---------- Spinks	A	None--------	---	---	>6.0	---	---	---	---	Low------	Lo
9A, 9B, 9C, 9D---- Kalamazoo	B	None--------	---	---	>6.0	---	---	---	---	Moderate	Lo
11---------- Edwards	B/D	None--------	---	---	+1-1.0	Apparent	Sep-Jun	4-12	25-30	High-----	Hi
12A---------- Brady	B	None--------	---	---	1.0-3.0	Apparent	Nov-May	---	---	High-----	Lo
15---------- Glendora	A/D	Frequent----	Long------	Jan-Dec	0-1.0	Apparent	Nov-Jun	---	---	Moderate	Hi
16B, 16C---------- Ormas	B	None--------	---	---	>6.0	---	---	---	---	Moderate	Lo
18---------- Barry	B/D	None--------	---	---	+1-1.0	Apparent	Nov-May	---	---	High-----	Hi
19---------- Houghton	A/D	None--------	---	---	+1-1.0	Apparent	Sep-Jun	1-4	55-60	High-----	Hi
20A---------- Bronson	B	None--------	---	---	2.0-3.5	Apparent	Nov-May	---	---	High-----	Lo
24---------- Adrian	A/D	None--------	---	---	+1-1.0	Apparent	Nov-May	---	29-33	High-----	Hi

TABLE 19.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Subsidence		Potential frost action	R
		Frequency	Duration	Months	Depth	Kind	Months	Initial	Total		
					Ft			In	In		
26C, 26D, 26E----- Riddles	B	None--------	---	---	>6.0	---	---	---	---	Moderate	Mo
27A----------- Tedrow	B	None--------	---	---	1.0-2.0	Apparent	Jan-Apr	---	---	Moderate	Lo
28A----------- Teasdale	B	None--------	---	---	1.0-2.0	Apparent	Nov-May	---	---	High-----	Mo
29----------- Palms	A/D	None--------	---	---	+1-1.0	Apparent	Nov-May	2-4	25-32	High-----	Hi
30A, 30B---------- Elston	B	None--------	---	---	>6.0	---	---	---	---	Low------	Lo
34. Pits											
36----------- Gilford	B/D	None--------	---	---	+.5-1.0	Apparent	Dec-May	---	---	High-----	Hi
37B---------- Brems	A	None--------	---	---	2.0-3.0	Apparent	Jan-Apr	---	---	Low------	Lo
38----------- Napoleon	A/D	None--------	---	---	+1-1.0	Apparent	Sep-Jun	22-26	50-59	High-----	Mo
39----------- Cohoctah	D	Frequent----	Brief to long.	Nov-May	0-1.0	Apparent	Sep-May	---	---	High-----	Hi
40B, 40C---------- Coloma	A	None--------	---	---	>6.0	---	---	---	---	Low------	Lo
41B, 41C, 41D, 41E:											
Spinks----------	A	None--------	---	---	>6.0	---	---	---	---	Low------	Lo
Oshtemo---------	B	None--------	---	---	>6.0	---	---	---	---	Low------	Lo
42: Udipsamments.											
Udorthents.											
44B: Urban land.											
Spinks----------	A	None--------	---	---	>6.0	---	---	---	---	Low------	Lo

TABLE 19.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Subsidence		Potential frost action	R
		Frequency	Duration	Months	Depth	Kind	Months	Initial	Total		
					Ft			In	In		
45B:											
Urban land.											
Kalamazoo	B	None	---	---	>6.0	---	---	---	---	Moderate	Lo
46B	B	None	---	---	2.5-6.0	Apparent	Jan-Apr	---	---	Moderate	Mo
Cassopolis											

TABLE 20.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Adrian	Sandy or sandy-skeletal, mixed, euic, mesic Terric Medisaprists
Aquents	Mixed, nonacid, mesic Aquents
Barry	Fine-loamy, mixed, mesic Typic Argiaquolls
*Brady	Coarse-loamy, mixed, mesic Aquollic Hapludalfs
Brems	Mixed, mesic Aquic Udipsamments
*Bronson	Coarse-loamy, mixed, mesic Aquic Hapludalfs
Cassopolis	Fine-loamy, mixed, mesic Haplic Glossudalfs
Cohoctah	Coarse-loamy, mixed, mesic Fluvaquentic Haplaquolls
Coloma	Mixed, mesic Alfic Udipsamments
Edwards	Marly, euic, mesic Limnic Medisaprists
Elston	Coarse-loamy, mixed, mesic Typic Argiudolls
Gilford	Coarse-loamy, mixed, mesic Typic Haplaquolls
*Glendora	Mixed, mesic Mollic Psammaquents
Histosols	Euic, mesic Histosols
Houghton	Euic, mesic Typic Medisaprists
Kalamazoo	Fine-loamy, mixed, mesic Typic Hapludalfs
Napoleon	Dysic, mesic Typic Medihemists
Ormas	Loamy, mixed, mesic Arenic Hapludalfs
Oshtemo	Coarse-loamy, mixed, mesic Typic Hapludalfs
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Riddles	Fine-loamy, mixed, mesic Typic Hapludalfs
Schoolcraft	Fine-loamy, mixed, mesic Typic Argiudolls
Spinks	Sandy, mixed, mesic Psammentic Hapludalfs
*Teasdale	Coarse-loamy, siliceous, mesic Glossaquic Hapludalfs
Tedrow	Mixed, mesic Aquic Udipsamments
Udipsamments	Mixed, mesic Udipsamments
Udorthents	Loamy, mixed, mesic Udorthents

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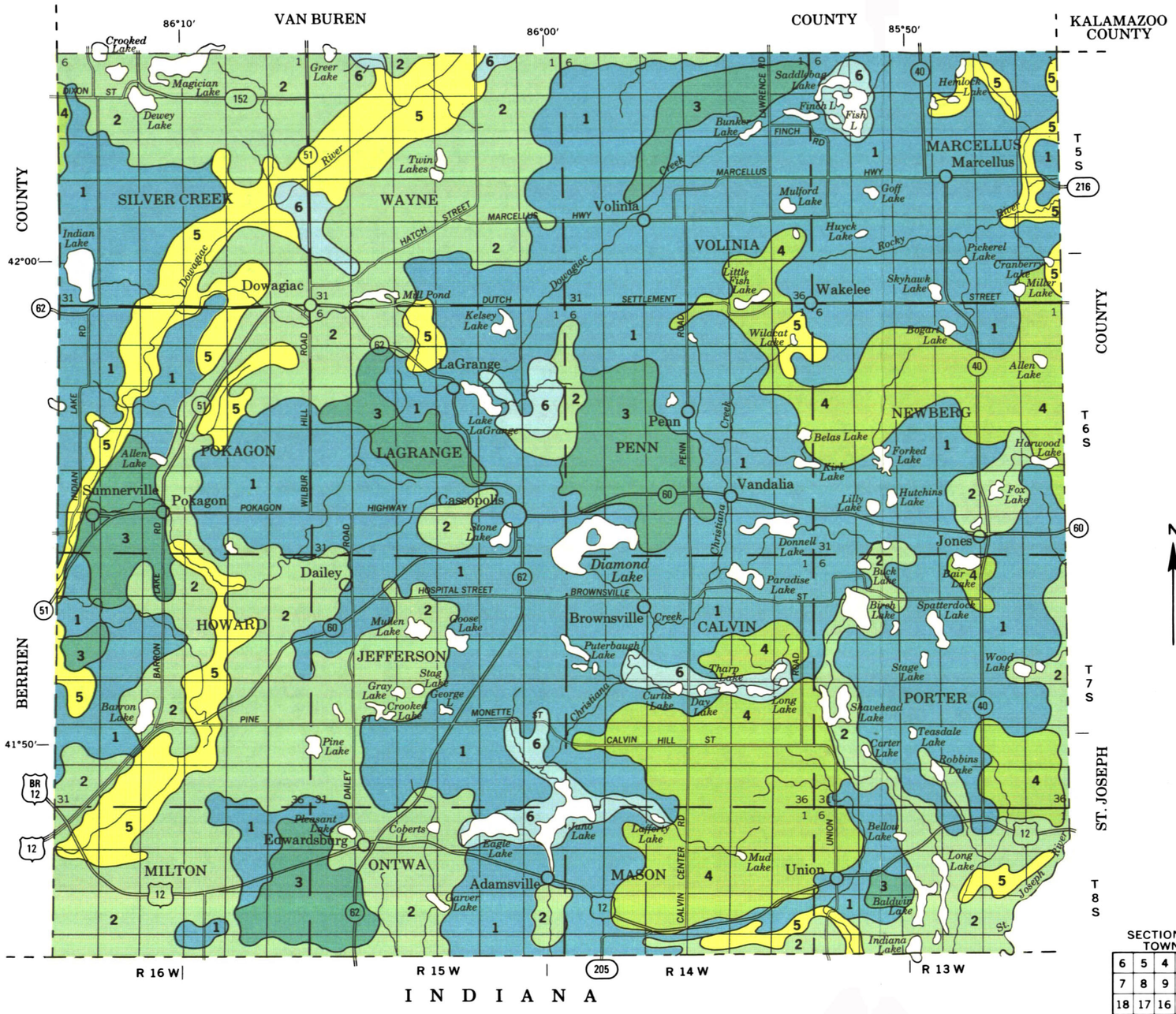


SOIL LEGEND*

1. KALAMAZOO-OSHTEMO ASSOCIATION: Nearly level to hilly, well drained, loamy soils; on outwash plains and moraines
2. SPINKS-OSHTEMO-ORMAS ASSOCIATION: Nearly level to steep, well drained, sandy and loamy soils; on outwash plains and moraines
3. SCHOOLCRAFT-ELSTON ASSOCIATION: Nearly level and undulating, well drained, loamy soils; on outwash plains
4. CASSOPOLIS-RIDDLES-TEASDALE ASSOCIATION: Nearly level to steep, well drained to somewhat poorly drained, loamy soils; on till plains and moraines
5. GLENDORA-ADRIAN-COHOCTAH ASSOCIATION: Nearly level, very poorly drained, mucky and loamy soils; on flood plains and in old glacial lakebeds
6. HOUGHTON ASSOCIATION: Nearly level, very poorly drained, mucky soils; in old glacial lakebeds

* The texture terms in the descriptive headings refer to the surface layer of the major soils in the associations.

Compiled 1988

N

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MICHIGAN DEPARTMENT OF AGRICULTURE
MICHIGAN AGRICULTURAL EXPERIMENT STATION
MICHIGAN TECHNOLOGICAL UNIVERSITY

GENERAL SOIL MAP

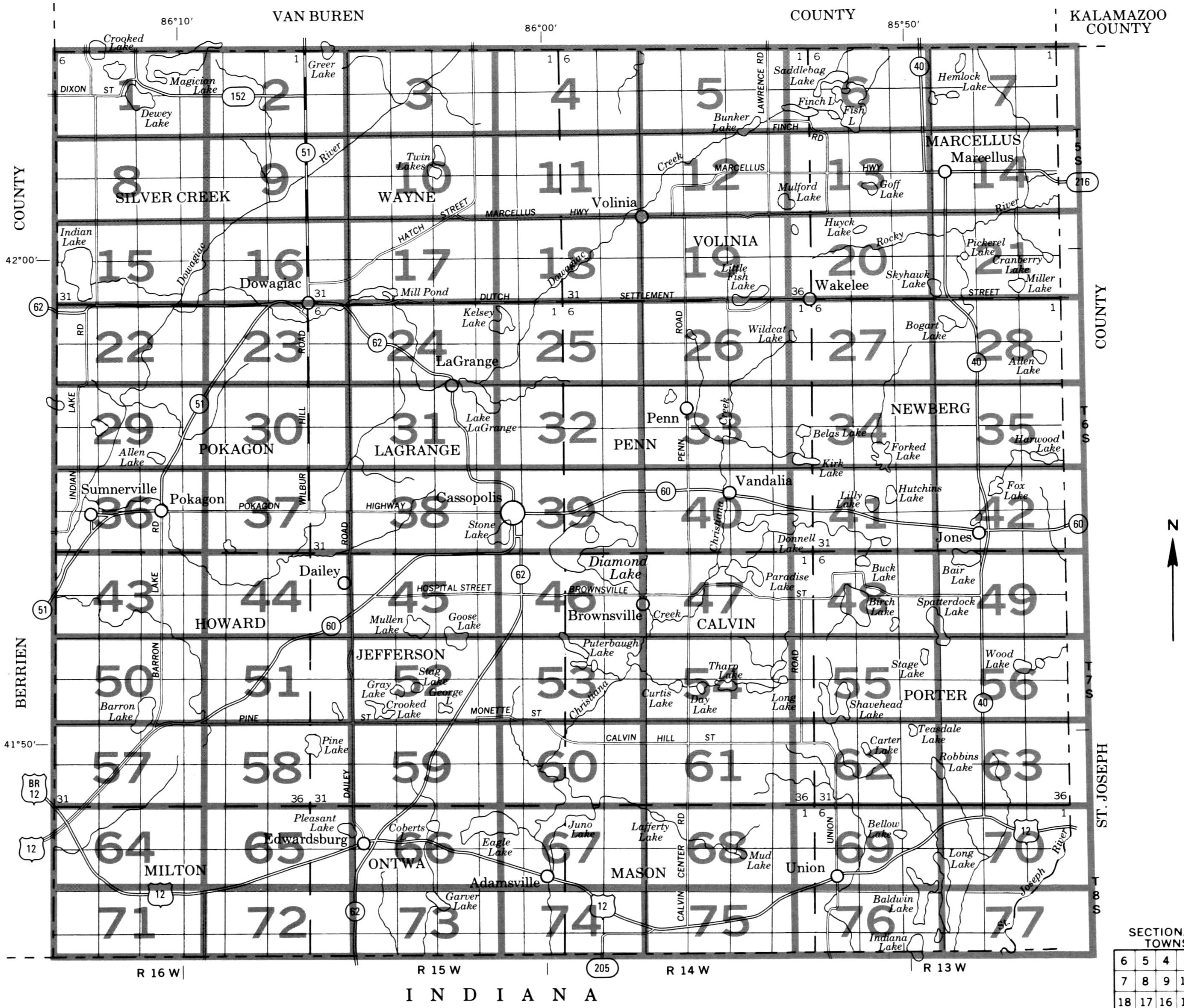
CASS COUNTY, MICHIGAN

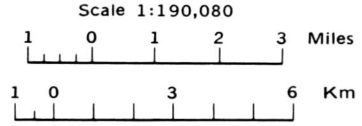
Scale 1:190,080

1 0 1 2 3 Miles

1 0 3 6 Km

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.





SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

CASS COUNTY, MICHIGAN

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and letters. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas.

SYMBOL	NAME
2	Histosols and Aquents, ponded
3A	Schoolcraft loam, 0 to 2 percent slopes
3B	Schoolcraft loam, 2 to 4 percent slopes
4A	Oshtemo sandy loam, 0 to 2 percent slopes
4B	Oshtemo sandy loam, 2 to 6 percent slopes
4C	Oshtemo sandy loam, 6 to 12 percent slopes
4D	Oshtemo sandy loam, 12 to 18 percent slopes
5B	Spinks loamy sand, 0 to 6 percent slopes
5C	Spinks loamy sand, 6 to 12 percent slopes
9A	Kalamazoo loam, 0 to 2 percent slopes
9B	Kalamazoo loam, 2 to 6 percent slopes
9C	Kalamazoo loam, 6 to 12 percent slopes
9D	Kalamazoo loam, 12 to 18 percent slopes
11	Edwards muck
12A	Brady sandy loam, 0 to 2 percent slopes
15	Glendora muck
16B	Ormas loamy sand, 0 to 6 percent slopes
16C	Ormas loamy sand, 6 to 12 percent slopes
18	Barry loam
19	Houghton muck
20A	Bronson loamy sand, 0 to 3 percent slopes
24	Adrian muck
26C	Riddles fine sandy loam, 6 to 12 percent slopes
26D	Riddles fine sandy loam, 12 to 18 percent slopes
26E	Riddles fine sandy loam, 18 to 35 percent slopes
27A	Tedrow loamy sand, 0 to 3 percent slopes
28A	Teasdale fine sandy loam, 0 to 3 percent slopes
29	Palms muck
30A	Elston sandy loam, 0 to 2 percent slopes
30B	Elston sandy loam, 2 to 6 percent slopes
34	Pits
36	Gilford sandy loam
37B	Brems loamy sand, 0 to 6 percent slopes
38	Napoleon muck
39	Cohoctah loam
40B	Coloma loamy sand, 0 to 6 percent slopes
40C	Coloma loamy sand, 6 to 12 percent slopes
41B	Spinks-Oshtemo complex, 2 to 6 percent slopes
41C	Spinks-Oshtemo complex, 6 to 12 percent slopes
41D	Spinks-Oshtemo complex, 12 to 18 percent slopes
41E	Spinks-Oshtemo complex, 18 to 35 percent slopes
42	Udipsamments and Udorthents, nearly level
44B	Urban land-Spinks complex, 0 to 6 percent slopes
45B	Urban land-Kalamazoo complex, 0 to 6 percent slopes
46B	Cassopolis fine sandy loam, 3 to 6 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline and neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool (Swift Airport; FLOOD POOL LINE)

STATE COORDINATE TICK

LAND DIVISION CORNER (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate (21)
- Federal (173)
- State (28)
- County, farm or ranch (1283)

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or Small (water; w)

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) (Indian Mound)
- Located object (label) (Tower)
- Tank (label) (Gas)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) (CANAL)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial (water; w)
- Intermittent (int; i)

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

- SOIL DELINEATIONS AND SYMBOLS (27A 28A)
- ESCARPMENTS
  - Bedrock (points down slope)
  - Other than bedrock (points down slope)
- SHORT STEEP SLOPE
- GULLY
- DEPRESSION OR SINK
- SOIL SAMPLE (normally not shown) (S)
- MISCELLANEOUS
  - Blowout
  - Clay spot
  - Gravelly spot
  - Gumbo, slick or scabby spot (sodic)
  - Dumps and other similar non soil areas
  - Prominent hill or peak
  - Rock outcrop (includes sandstone and shale)
  - Saline spot
  - Sandy spot
  - Severely eroded spot
  - Slide or slip (tips point upslope)
  - Stony spot, very stony spot (0)
  - Loamy spot < 3 acres

SOIL MAP OF CASS COUNTY, MICHIGAN — SHEET NUMBER 1

CASS COUNTY, MICHIGAN NO. 1

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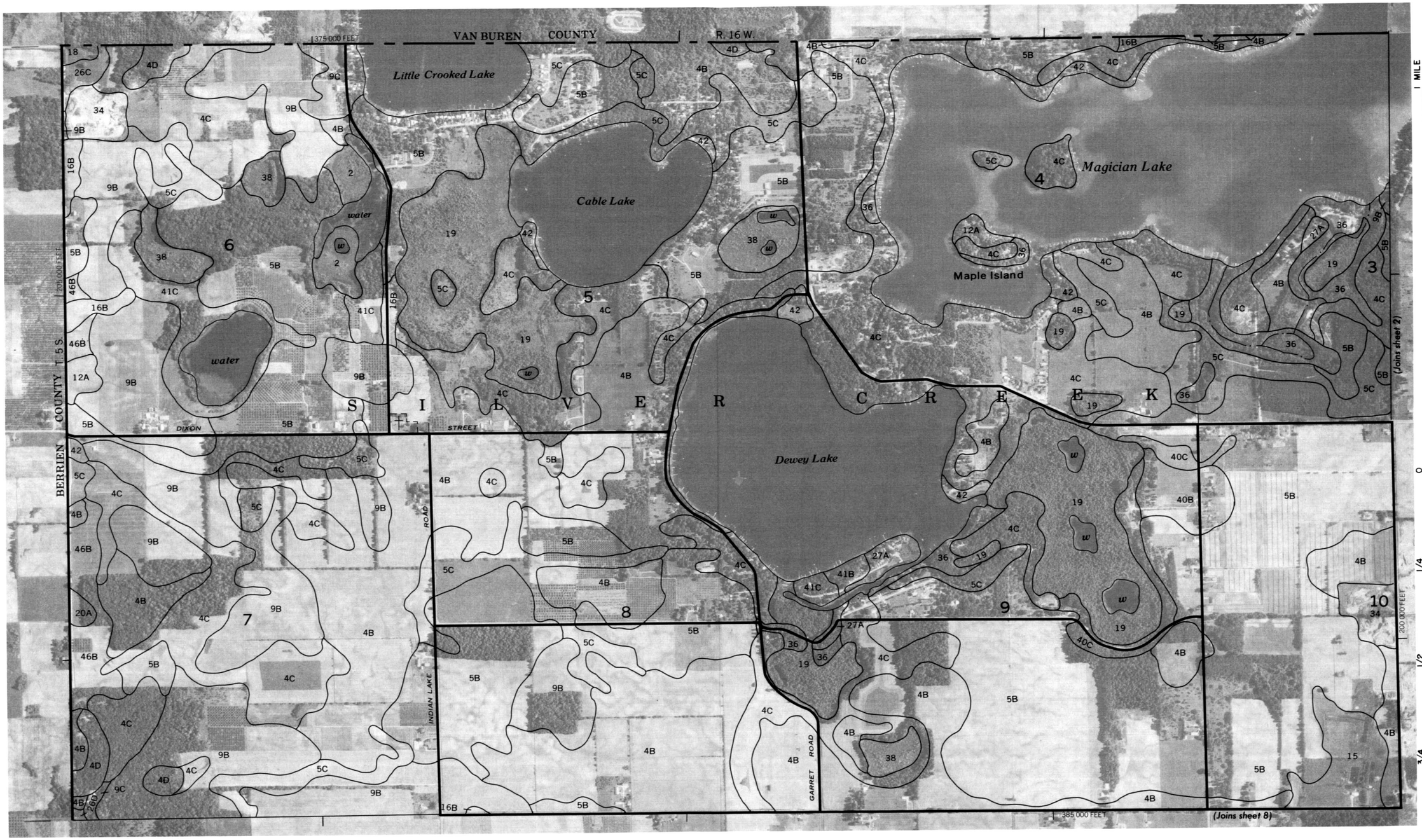
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



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CASS COUNTY, MICHIGAN NO. 2

SOIL MAP OF CASS COUNTY, MICHIGAN — SHEET NUMBER 3

3

N

CASS COUNTY, MICHIGAN NO. 3

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410 000 FEET

VAN BUREN COUNTY

R. 15 W.

T. 5 S.

200 000 FEET

Pitcher Lake

Dewey Lake

River

ROAD

STREET

Glenwood

CORPORATION

CONSOLIDATED

RAIL

TWIN LAKES

ATWOOD

Dowagiac

(Joins sheet 2)

(Joins sheet 4)

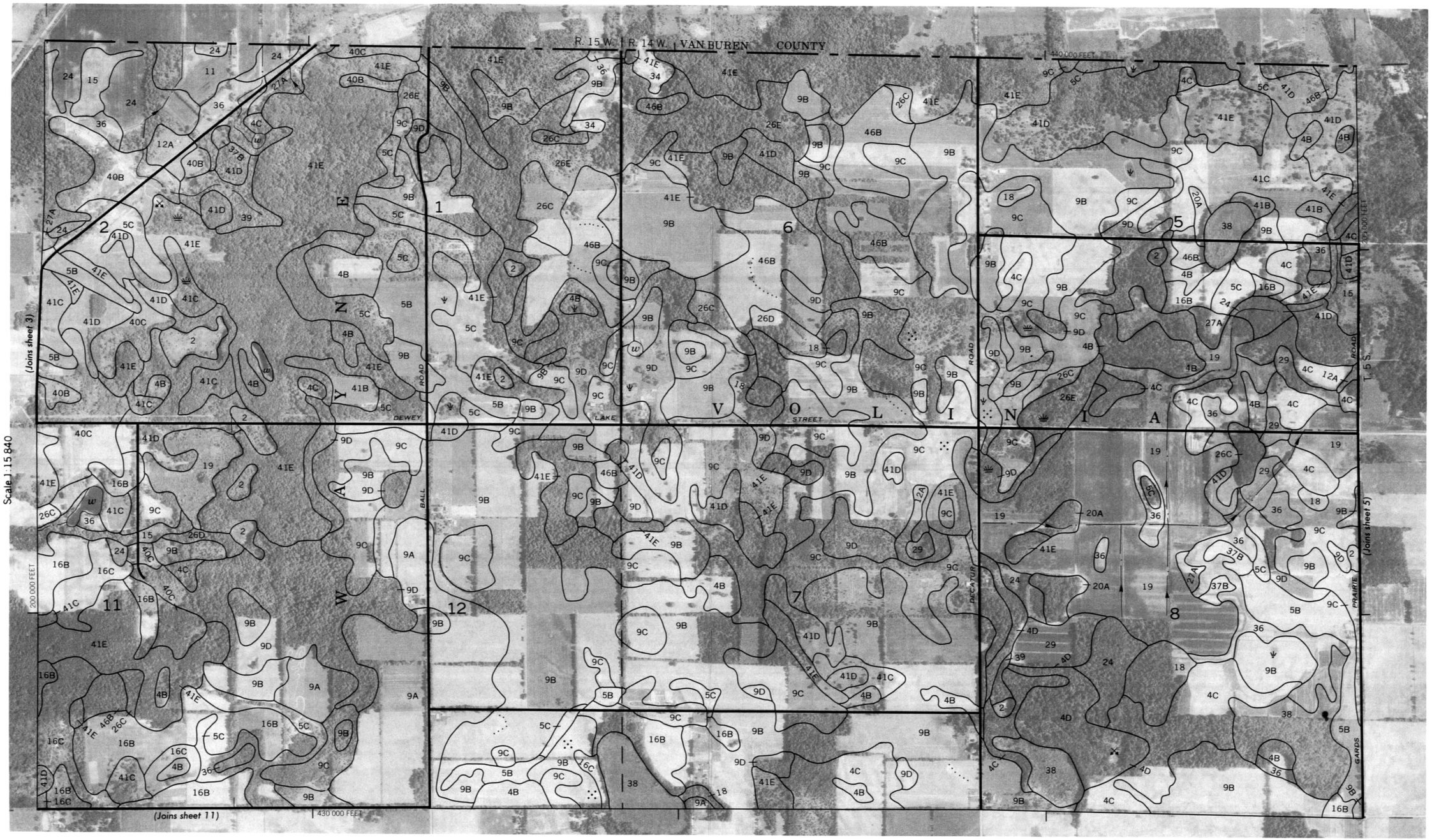
(Joins sheet 10)

425 000 FEET

1 MILE

1 KILOMETER

Scale 1:15 840



Scale 1:15 840

1 MILE 0 1/4 1/2 3/4 1

1 KILOMETER 0 0.5 1

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Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 4

N

VAN BUREN COUNTY R. 14 W.

445 000 FEET

208 000 FEET

T. 5 S.

(Joins sheet 6)

(Joins sheet 4)

(Joins sheet 12)

460 000 FEET

200 000 FEET

DEWEY LAKE

Finch Lake

Bunker Lake

Nicholsville

VOLINIA

ROAD

GARDS PRAIRIE ROAD

GOODENOUGH ROAD

HATHAWAY ROAD

LAWRENCE ROAD

10 STREET

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 3/4

CASS COUNTY, MICHIGAN NO. 5

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

6

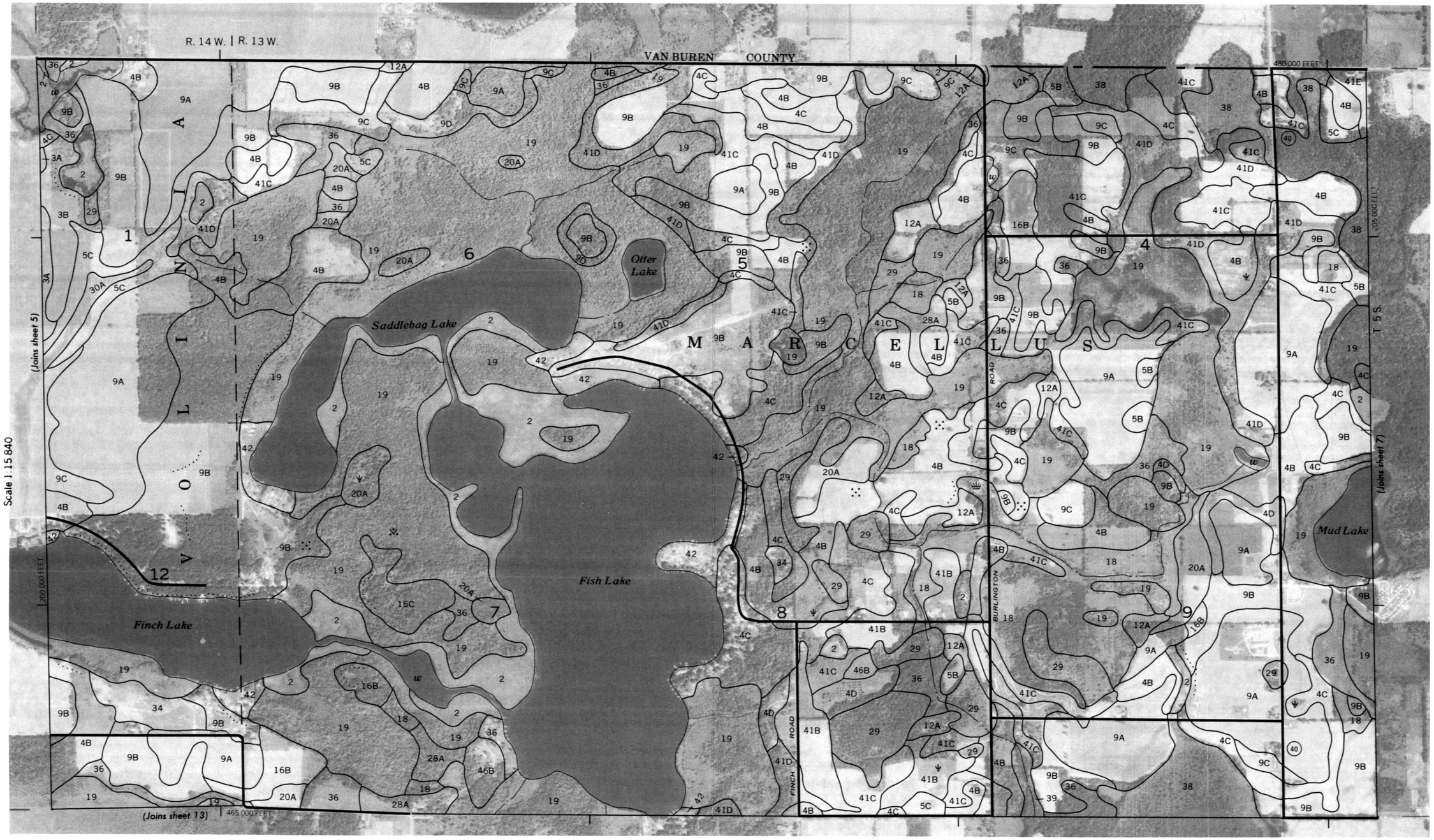
N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4 1



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CASS COUNTY, MICHIGAN NO. 6

CASS COUNTY, MICHIGAN NO. 7

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

7

N

485 000 FEET

VAN BUREN COUNTY

R. 13 W.

205 000 FEET

T. 5 S.

(Joins sheet 6)

Hemlock Lake

Pine Lake

Mud Lake

Spring Lake

Sheldon Creek

HEMLOCK LAKE ROAD

COUNTY ST. JOSEPH

GRAND TRUNK WESTERN KNIGHT ROAD

(Joins sheet 14)

495 000 FEET

200 000 FEET

MILE

KILOMETER

0 1/4 1/2 3/4 1

0 0.5

Scale 1:15 840

8

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 0.5 1

1/4 1/2 3/4 1

(Joins sheet 1)

R. 16 W.

385 000 FEET

195 000 FEET

190 000 FEET

375 000 FEET

T. 5 S.

(Joins sheet 9)

(Joins sheet 15)

BERRIEN COUNTY

INDIAN LAKE ROAD

GARRET ROAD

DOWNEY STREET

MIDDLE CROSSING STREET

SILVER CREEK

18 17 16 15

19 20 21 22

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CASS COUNTY, MICHIGAN NO. 8

CASS COUNTY, MICHIGAN NO. 9

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Coordinate grid ticks and land division corners, if shown, are approximately positioned

10

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4 1

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Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 10

CASS COUNTY, MICHIGAN NO. 11

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

R. 15 W. | R. 14 W.

430 000 FEET

195 000 FEET

(Joins sheet 4)

(Joins sheet 10)

(Joins sheet 12)

(Joins sheet 18)

440 000 FEET

190 000 FEET

14 13 18 17

23 24 19 20

WAYNE

VOLINIA

BALL ROAD

O'KEEFE ROAD

GAGE STREET

MARCELLUS HIGHWAY

DECATUR ROAD

Dowagiac Creek

Volinia

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 1/4 0.5 1/2 1 3/4

12

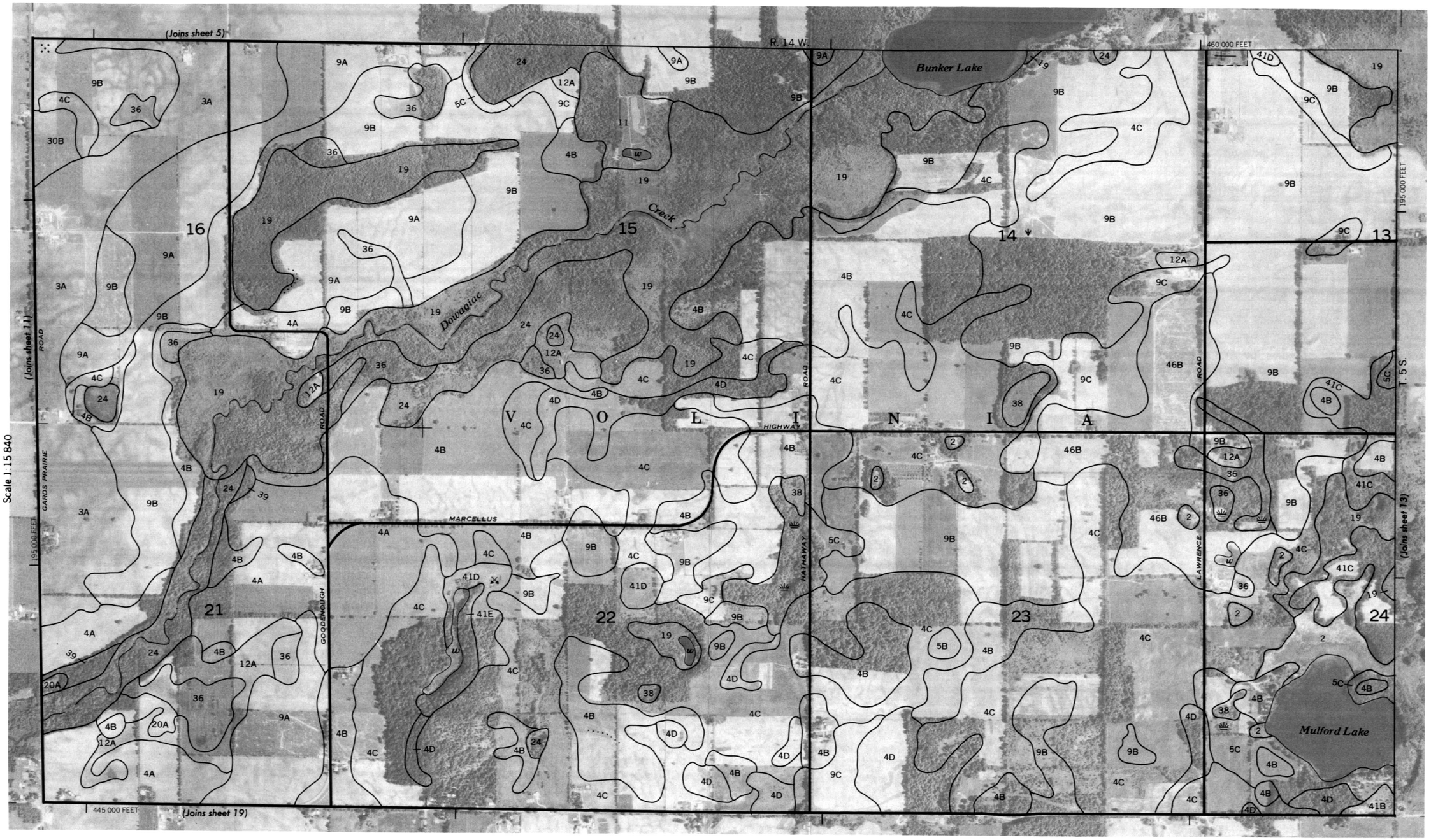
N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4 1



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CASS COUNTY, MICHIGAN NO. 12

CASS COUNTY, MICHIGAN NO. 13

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Coordinate grid ticks and land division corners, if shown are approximately positioned

13

N

R. 14 W. | R. 13 W.

465 000 FEET

195 000 FEET

(Joins sheet 6)

(Joins sheet 14)

(Joins sheet 12)

(Joins sheet 20)

480 000 FEET

190 000 FEET

MARCELLUS

HIGHWAY

ROAD

FINCH

BURLINGTON

GRAND TRUNK WESTERN

Goff Lakes

water

water

1 MILE

1 KILOMETER

Scale 1:15 840

1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840

14

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0.5 0

1/4 1/2 3/4 1

(Joins sheet 7)

(Joins sheet 13)

(Joins sheet 21)

R. 13 W.

495 000 FEET

490 000 FEET

485 000 FEET

T. 5 S.

MARCELLUS

WESTERN TRUNK GRAND

Creek

KNIGHT ROAD

ROAD

HEMLOCK LAKE

Sheldon

Lewis Lake

Rocky River

ST. JOSEPH COUNTY

CASS COUNTY, MICHIGAN

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

MICHIGAN NO. 14

15

N

CASS COUNTY, MICHIGAN NO. 15

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

Scale 1:15 840

1 MILE

1 KILOMETER

0 0 1/4 0.5 1/2 3/4 1

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 1/4 0.5 1/2 1 3/4 1

(Joins sheet 9)

(Joins sheet 15)

(Joins sheet 23)

(Joins sheet 17)

R. 16 W.

R. 15 W.

T. 5 S.

405 000 FEET

390 000 FEET

385 000 FEET

Dowagiac River

MIDDLE CROSSING STREET

YAW STREET

SILVER CREEK

WAYNE

Cook Lake

Pine Lake

County Memorial Airport

water

Mill Pond

DOWAGIAC

CONSOLIDATED RAIL CORPORATION

26 27 25 30 34 35 36 31

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY, MICHIGAN NO. 16

N

CASS COUNTY, MICHIGAN NO. 17

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

Scale 1:15 840

1 MILE
1 KILOMETER
0 0
1/4 0.5
1/2 1
3/4

18

N

Scale 1:15 840

1 MILE

1 KILOMETER

0 0.5 1

1/4 1/2 3/4 1

(Joins sheet 11)

(Joins sheet 17)

(Joins sheet 19)

(Joins sheet 25)

R. 15 W. | R. 14 W.

T. 5 S.

440 000 FEET

430 000 FEET

185 000 FEET

180 000 FEET

MARCELLUS HIGHWAY

O'KEEFE ROAD

DECATUR ROAD

DUTCH SETTLEMENT STREET

MCKENZIE STREET

Dowagiac Creek

26 25 30 29 35 36 31 32

WAYNE VOLINIA

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY, MICHIGAN NO. 18

N

R. 14 W.

T. 5 S.

445 000 FEET

185 000 FEET

460 000 FEET

180 000 FEET

(Joins sheet 12)

(Joins sheet 18)

(Joins sheet 20)

(Joins sheet 26)

MARCELLUS HIGHWAY

GARDS PRAIRIE ROAD

GOODENOUGH ROAD

LAWRENCE ROAD

VOLINIA STREET

MCKENZIE ROAD

DUTCH SETTLEMENT STREET

Copley Lake

Little Fish Lake

Scale 1:15 840

1 MILE

1 KILOMETER

0 0

1/4 0.5

1/2 1

3/4

CASS COUNTY, MICHIGAN NO. 19

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

20

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4 1

R. 14 W. | R. 13 W.

(Joins sheet 13)

480 000 FEET

185 000 FEET

T. 5 S.

(Joins sheet 19)

(Joins sheet 21)

(Joins sheet 27)

465 000 FEET

180 000 FEET

Copley Lake

Huyck Lake

Rocky River

water

Skyhawk Lake

FINCH ROAD

WESTERN ROAD

BURLINGTON TRUNK

WATERSTRADT STREET

GOFF ROAD

GRAND ROAD

SAVAGE ROAD

DUTCH SETTLEMENT STREET

MALLOW

25 30 29 28 31 32 33 36

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

MICHIGAN NO. 20

CASS COUNTY, MICHIGAN

SOIL MAP OF CASS COUNTY, MICHIGAN — SHEET NUMBER 21

21

N

CASS COUNTY, MICHIGAN NO. 21

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

485 000 FEET

385 000 FEET

R. 13 W.

(Joins sheet 14)

T. 5 S.

(Joins sheet 20)

Rocky River

Pickerel Lake

Skyhawk Lake

Cranberry Lake

Miller Lake

MARCELLUS

PIONEER STREET

DUTCH SETTLEMENT ROAD

MILLER ROAD

ST. JOSEPH COUNTY

27

26

25

34

35

36

495 000 FEET

(Joins sheet 28)

1 MILE

1 KILOMETER

0 1/4 1/2 3/4 1

0 0.5 1

180 000 FEET

Scale 1:15 840

22

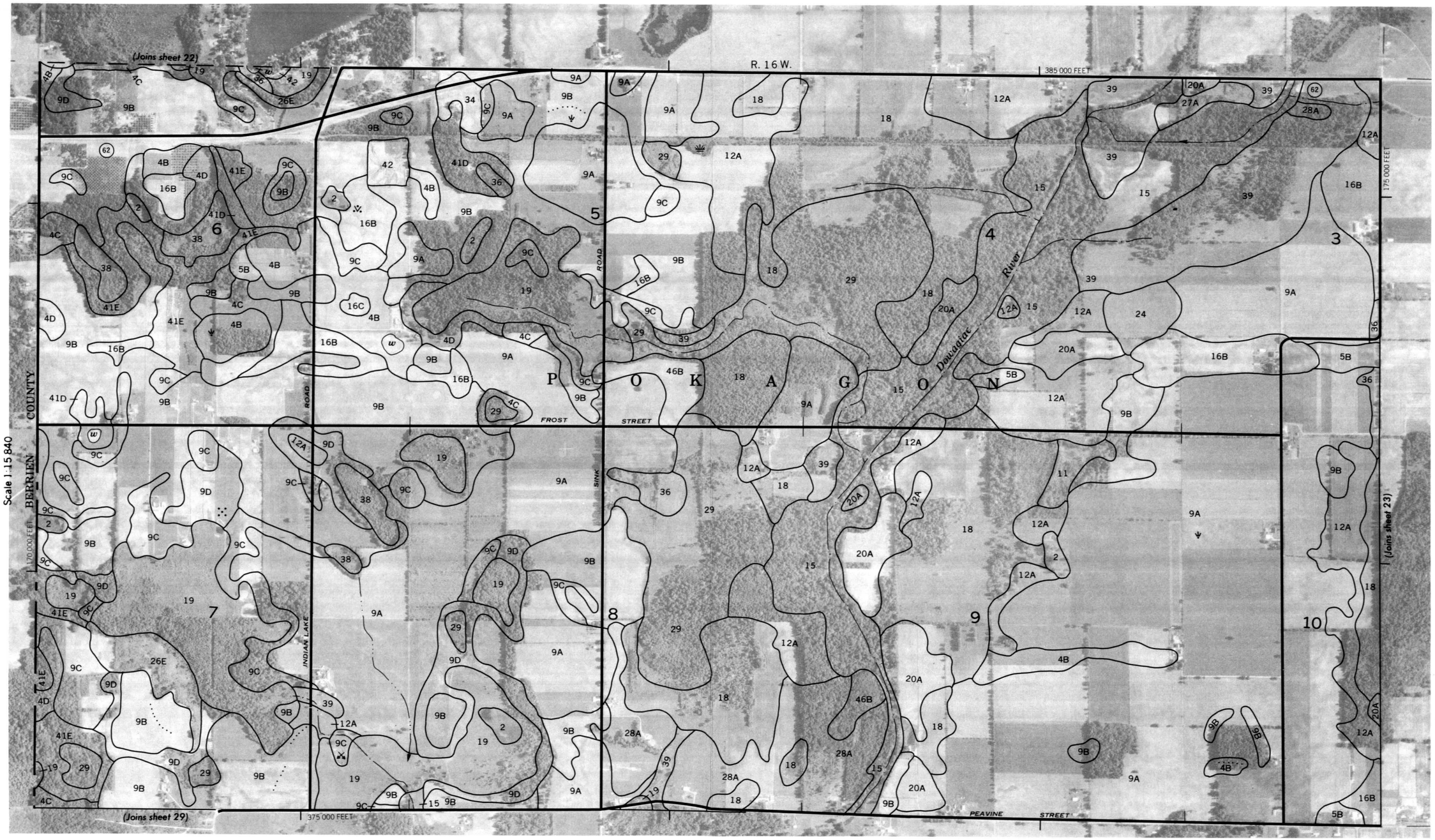
N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 0.5 1/4 1/2 3/4 1



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 22

CASS COUNTY, MICHIGAN NO. 23

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

N

MILE

KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4

24

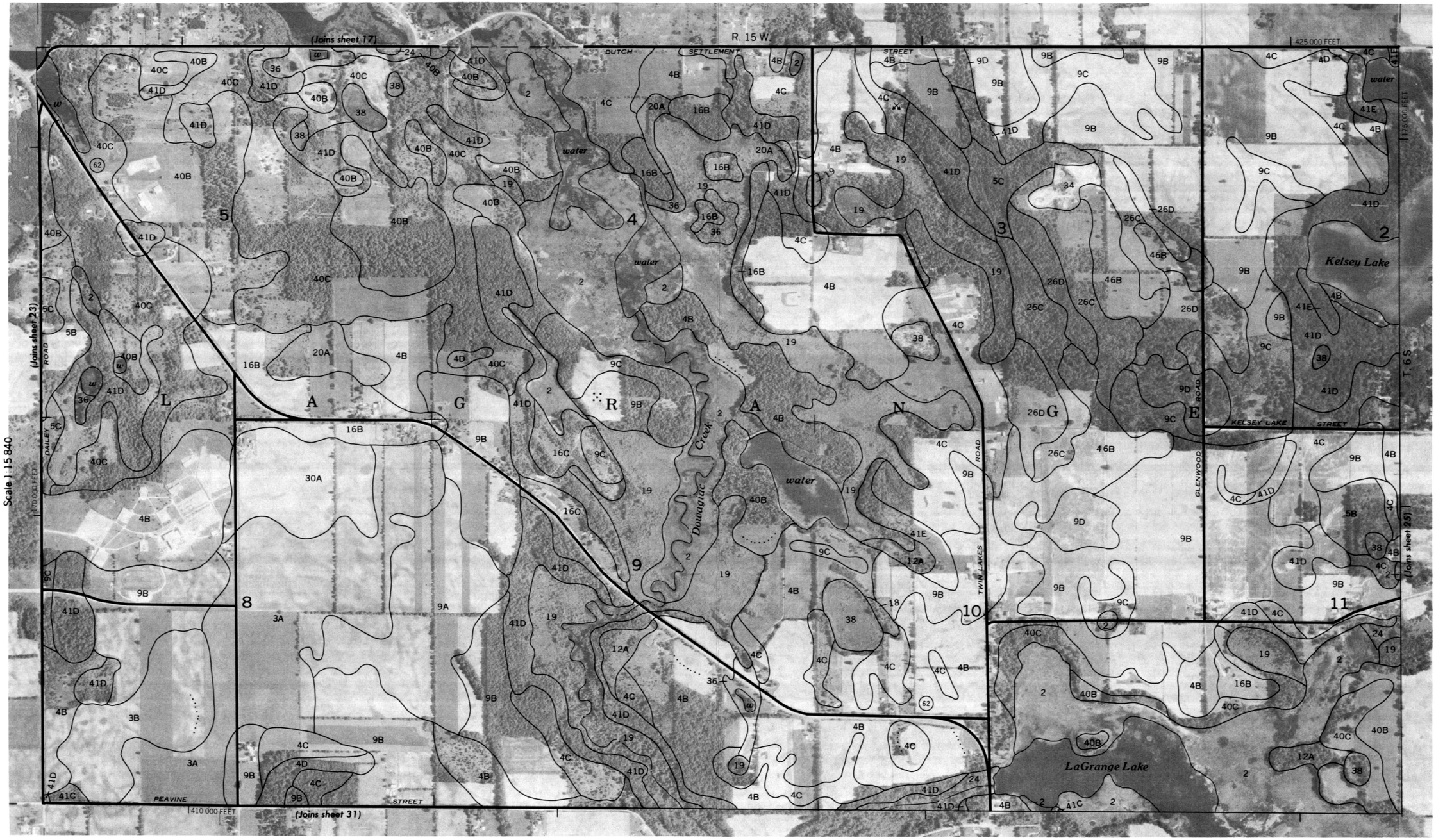
N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 3/4 1



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 24

25

N

R. 15 W. | R. 14 W.

430 000 FEET

135 000 FEET

(Joins sheet 18)

(Joins sheet 24)

(Joins sheet 26)

(Joins sheet 32)

440 000 FEET

T. 6 S.

ANGE

LAGRANGE

P E N E

Kelsey Lake

Dowagiac Creek

water

DUTCH SETTLEMENT STREET

KELSEY LAKE STREET

DECATUR ROAD

CARDS PRAIRIE ROAD

41E 9A 9B 4C 41D 5B 4B 15 16B 20A 24 1 2 19 27A 12A 40B 5C 4A 41C 6 5 3A 41B 36 12A 11 12 7 8 16C 30B 3B 9C

1 MILE

1 KILOMETER

170 000 FEET

0 0

1/4 0.5

1/2 1

3/4

Scale 1:15 840

CASS COUNTY, MICHIGAN NO. 25

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

26

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0

1/4 0.5

1/2 1

3/4

1

(Joins sheet 19)

(Joins sheet 25)

(Joins sheet 33)

(Joins sheet 27)

R. 14 W.

T. 6 S.

460 000 FEET

445 000 FEET

170 000 FEET

175 000 FEET

Little Fish Lake

Mud Lake

Creek

DUTCH SETTLEMENT

STREET

ROAD

PENN

HOFFMAN

GRAND

TRUNK

WESTERN

TEMPLE

WHITE

Christiana

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 26

N

CASS COUNTY, MICHIGAN NO. 27

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

R. 14 W. | R. 13 W.

465 000 FEET

175 000 FEET

100 000 FEET

480 000 FEET

(Joins sheet 20)

(Joins sheet 26)

(Joins sheet 28)

(Joins sheet 34)

T. 6 S.

Wakelee

Wildcat Lake

DUTCH SETTLEMENT STREET

HOFFMAN STREET

GRAND TRUNK WESTERN

N E 4C W

B E R G

P E N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4

28

N

Scale 1:15 840

1 MILE

1 KILOMETER

0 0 1/4 0.5 1/2 1 3/4

1700 FEET

(Joins sheet 21)

(Joins sheet 27)

(Joins sheet 35)

R. 13 W.

T. 6 S.

495 000 FEET

485 000 FEET

174 000 FEET

Skyhawk Lake

Streators Mill Pond

Bogart Lake

Allen Lake

Mt. Misery

ROAD

LUCAS

HOFFMAN

STREET

PATTERSON MILL RD

ST. JOSEPH COUNTY

BERRIEN COUNTY

1 2 3 10 11 12

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown are approximately positioned.

CASS COUNTY, MICHIGAN NO. 28

29

N

CASS COUNTY, MICHIGAN NO. 29

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

R. 16 W.

375 000 FEET

385 000 FEET

165 000 FEET

(Joins sheet 22)

(Joins sheet 30)

(Joins sheet 36)

Smith Lake

Rodgers Lake

Dowagiac River

PEAVINE STREET

COUNTY T. 6 S.

BERRIEN ROAD

INDIAN LAKE ROAD

CONSOLIDATED RAIL CORP.

17

18

16

15

19

20

21

22

POKAGON

1 MILE

1 KILOMETER

Scale 1:15 840

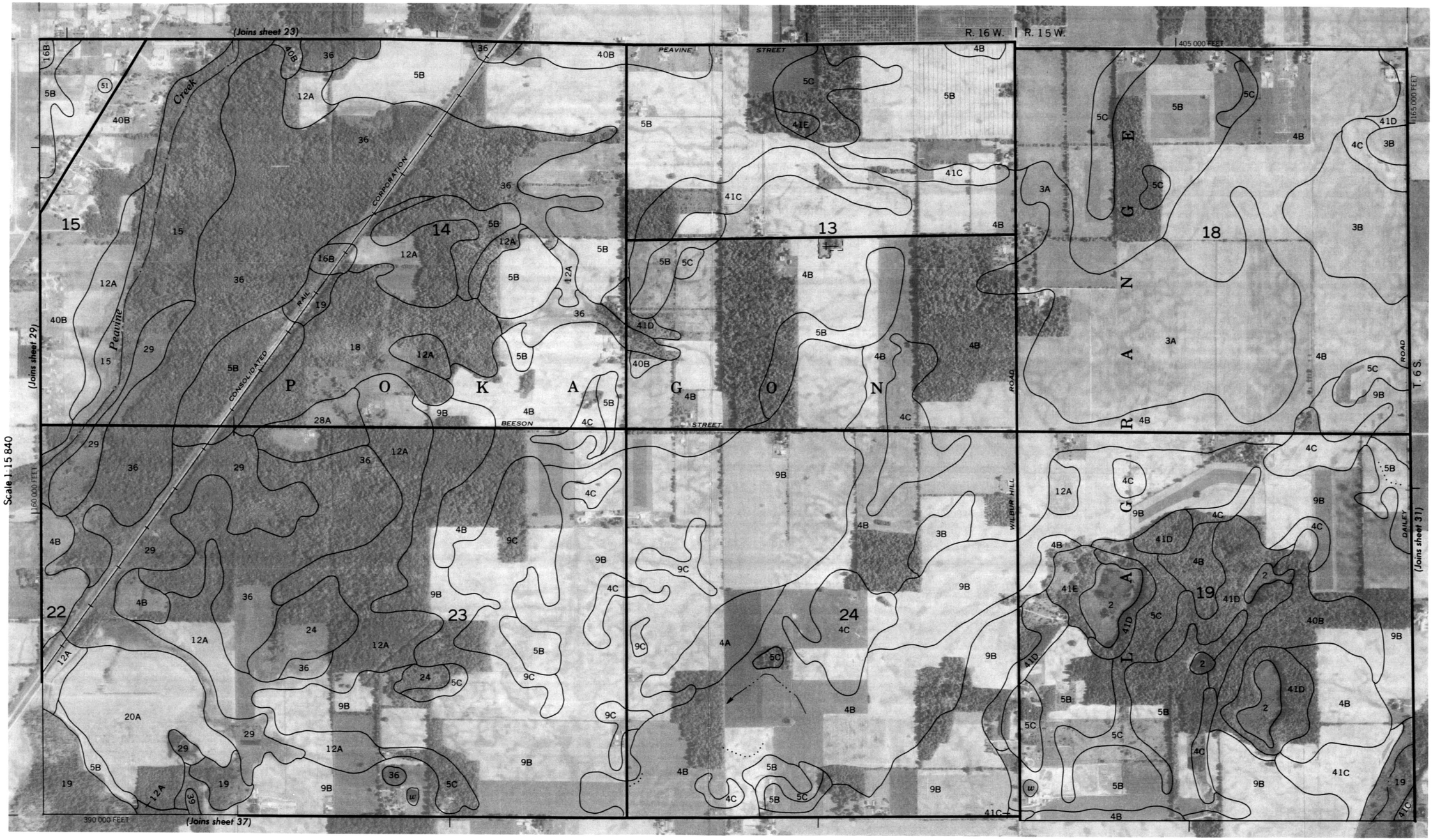
30

N

1 MILE

1 KILOMETER

Scale 1:15 840



This soil survey map is compiled on 1979 aerial photography by the U S Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 30

N

CASS COUNTY, MICHIGAN NO. 31

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

410 000 FEET

165 000 FEET

R. 15 W.

PEAVINE STREET

La Grange

Lake LaGrange

SHURTIE STREET

BEESON STREET

T. 6 S.

17

16

15

14

21

20

22

23

L A G R A N G E

Creek

Pokagon

DAILEY ROAD

OAK GROVE ROAD

(Joins sheet 30)

(Joins sheet 32)

(Joins sheet 38)

425 000 FEET

1 MILE

1 KILOMETER

Scale 1:15 840

32

N

1 MILE

1 KILOMETER

Scale 1 : 15 840

0 0.5 1

1/4 1/2 3/4

(Joins sheet 25)

(Joins sheet 31)

(Joins sheet 39)

(Joins sheet 33)

R. 15 W. | R. 14 W.

T. 6 S.

440 000 FEET

430 000 FEET

165 000 FEET

Lake LaGrange

QUAKER STREET

SHURTIE STREET

WESTERN TRUNK GRAND

O'KEEFFE ROAD

DECATUR ROAD

GARDS PRAIRIE ROAD

13 14 17 18 19 20 23 24

LAGRANGE

PENN

2 4B 4C 5B 5C 9B 9C 12A 16B 18 19 24 26C 27A 30A 30B 34 40B 40C 41C 41D 41E 46B 3A 3B

w

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

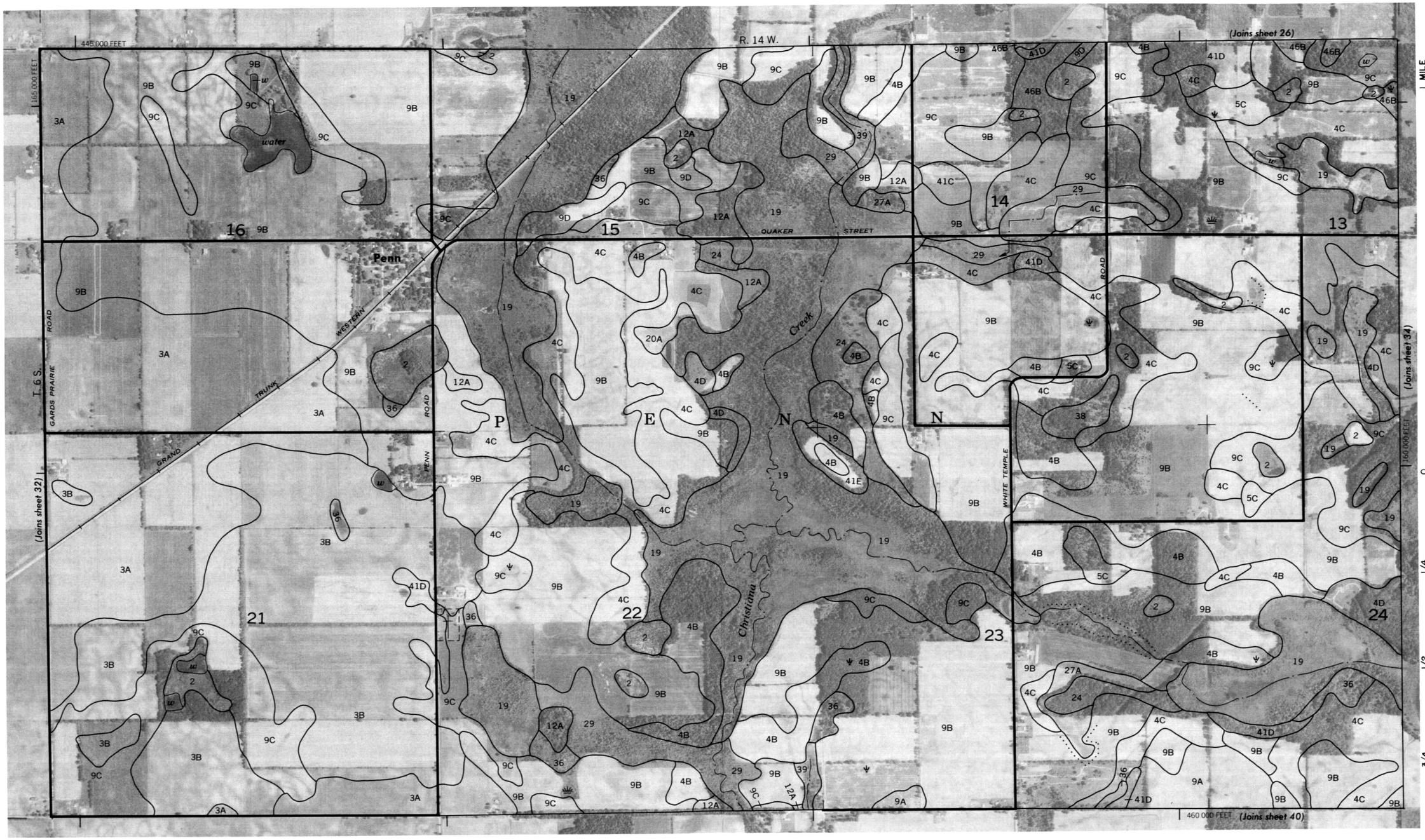
NO. 32

CASS COUNTY, MICHIGAN

N

CASS COUNTY, MICHIGAN NO. 33

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



1 MILE
1 KILOMETER
0 0
1/4 0.5
1/2 1
3/4

Scale 1:15 840

N

1 MILE

1 KILOMETER

Scale 1:15 840

R. 14 W. | R. 13 W.

(Joins sheet 27)

(Joins sheet 33)

(Joins sheet 41) | 465 000 FEET

480 000 FEET

165 000 FEET

160 000 FEET

T. 6 S.

(Joins sheet 35)

Belas Lake

Kirk Lake

Forked Lake

Bald Hill

QUAKER STREET

ROAD

BALD HILL STREET

SALVAGE

PATTERSON

13

18

17

16

19

20

21

24

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 34

N

R. 13 W.

485 000 FEET

165 000 FEET

160 000 FEET

495 000 FEET

T. 6 S.

(Joins sheet 28)

(Joins sheet 34)

(Joins sheet 42)

15

14

13

22

23

24

ST. JOSEPH COUNTY

BALD HILL ROAD

PATTERSON HILL ROAD

COREY LAKE ROAD

Harwood Lake

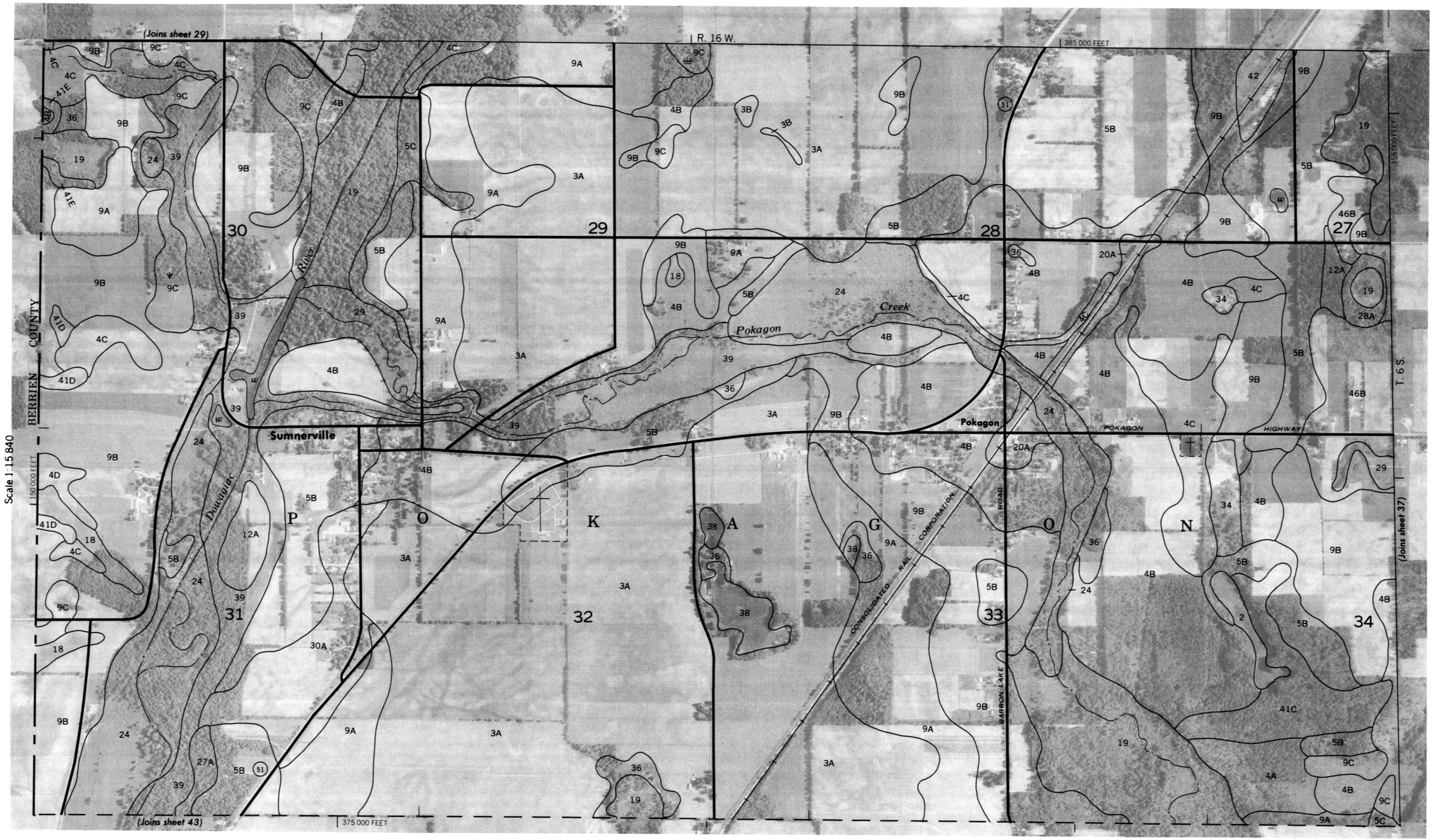
1 MILE

1 KILOMETER

Scale 1:15 840

CASS COUNTY, MICHIGAN NO. 35

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

NO. 36

CASS COUNTY, MICHIGAN

CASS COUNTY, MICHIGAN NO. 37

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

37

N

R.16 W. | R. 15 W.

390 000 FEET

150 000 FEET

(Joins sheet 30)

T. 6 S.

(Joins sheet 36)

(Joins sheet 38)

405 000 FEET (Joins sheet 44)

POKAGON HIGHWAY

WILBUR ROAD

ANDERSON ROAD

HILL ROAD

DAILEY ROAD

Pokagon Creek

water

26 25 30 27 35 36 34 31

T 6 S

R 16 W

R 15 W

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4

38

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0.5 0

1/4 1/2 3/4 1

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 38

CASS COUNTY, MICHIGAN NO. 39

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

N

R. 15 W. | R. 14 W.

430 000 FEET

155 000 FEET

T. 6 S.

(Joins sheet 32)

(Joins sheet 38)

(Joins sheet 40)

(Joins sheet 46)

440 000 FEET

440 000 FEET

O'KEEFE ROAD

DECATUR ROAD

WESTERN TRUNK GRAND TRUNK WESTERN

CASSOPOLIS
(county seat)

Stone Lake

Diamond Lake

Diamond Island

Diamond Shores

Spring Beach

26 25 30 29 35 36 31 32

28A 9B 5B 4C 4B 62 46B 5C 44B 45B 4D 41E 42 3A 3B 9C 9A 40C 20A 19 36 60

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 3/4 1

(40)

N

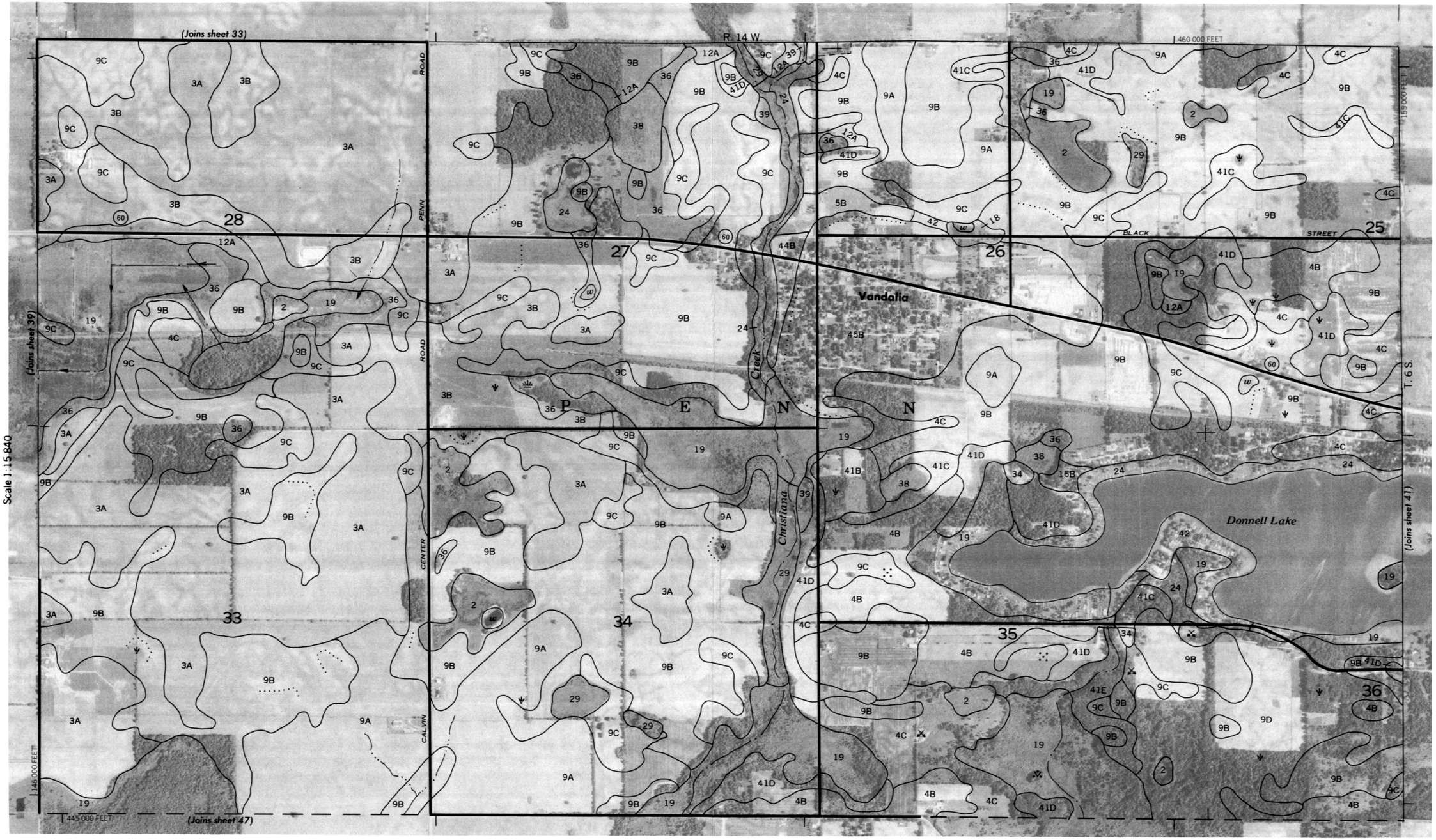
1 MILE

1 KILOMETER

Scale 1:15,840

0 0 0.5 1

1/4 1/2 3/4 1



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY, MICHIGAN NO. 40

41

CASS COUNTY, MICHIGAN NO. 41

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 3/4 1

R. 14 W. | R. 13 W.

465 000 FEET

155 000 FEET

T. 6 S.

(Joins sheet 34)

(Joins sheet 40)

(Joins sheet 42)

(Joins sheet 48)

480 000 FEET

146 000 FEET

Hutchens Lake

Lilly Lake

Donnell Lake

Lewis Lake

Lime Lakes

water

STREET

ROAD

SAVAGE

BLACK

BAMP LAKE

HILL

PATTERSON

25 30 29 28 36 31 32 33

42

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4 1

(Joins sheet 35)

(Joins sheet 41)

(Joins sheet 49)

R. 13 W.

T. 6 S.

ST. JOSEPH COUNTY

CASS COUNTY

1 495 000 FEET

1 485 000 FEET

1 505 000 FEET

Fox Lake

Driskell Lake

Bair Lake

Jones

Corey

BAIR LAKE ROAD

WOOD LAKE

COREY LAKE ROAD

STREET

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 42

N

CASS COUNTY, MICHIGAN NO. 43

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

375 000 FEET

R. 16 W.

(Joins sheet 36)

145 000 FEET

COUNTY T 7 S

BERRIEN

Dowagiac River

Pokagon Creek

McKinzie Creek

RAIL CORPORATION

CONSOLIDATED

THOMPSON ROAD

WHITE STREET

BARRON LAKE ROAD

HOWARD

6 5 4 3

7 8 9 10

(Joins sheet 44)

385 000 FEET

(Joins sheet 50)

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4 1 135 000 FEET

44

N

1 MILE

1 KILOMETER

Scale 1:15 840

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 44

45

N

410 000 FEET

145 000 FEET

R. 15 W.

(Joins sheet 38)

(Joins sheet 46)

(Joins sheet 44)

(Joins sheet 52)

T. 7 S.

HOSPITAL

ROAD

STREET

MULLEN

WESTERN

GRAND TRUNK

Mullen Lake

Goose Lake

water

425 000 FEET

135 000 FEET

1 MILE

1 KILOMETER

Scale 1:15 840

0 1/4 1/2 3/4 1

0 0.5 1

CASS COUNTY, MICHIGAN NO. 45

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

46

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0.5 1

1/4 1/2 3/4

R. 15 W. | R. 14 W.

T. 7 S.

440 000 FEET

140 000 FEET

135 000 FEET

430 000 FEET

(Joins sheet 39)

(Joins sheet 45)

(Joins sheet 47)

(Joins sheet 53)

Eagle Point

Diamond Lake

WESTERN

TRUNK

GRAND

HOSPITAL STREET

BROWNSVILLE STREET

CASSOPOLIS STREET

JEFFERSON CALVIN

1 2 5 6 7 8 11 12

4B 2 41E 12A 5C 62 9B 9C 9A 4C 42 20A 19 29 34 5B 26C 41D 40B 40C 38 41C 16C 18 41E 36 28A 39 w

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 46

N

R. 14 W.

(Joins sheet 40)

T. 7 S.

140 000 FEET

Paradise Lake

BROWNSVILLE ROAD

CENTER ROAD

CALVIN ROAD

LAKE ROAD

DAY ROAD

Christiana Creek

(Joins sheet 46)

(Joins sheet 48)

(Joins sheet 54)

450 000 FEET

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 3/4

CASS COUNTY, MICHIGAN NO. 47

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

48

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 0.5 1/4 1/2 3/4 1

R. 14 W. | R. 13 W. (Joins sheet 41)

(Joins sheet 47)

480 000 FEET

140 000 FEET

T. 7 S.

465 000 FEET

(Joins sheet 55)

(Joins sheet 49)

Buck Lake

Birch Lake

Elbow Lake

Spatterdock Lake

Williamsville

HARVEY STREET

WALNUT ROAD

ROBBINS LAKE ROAD

water

T 7 S

R 14 W

R 13 W

1 6 5 4

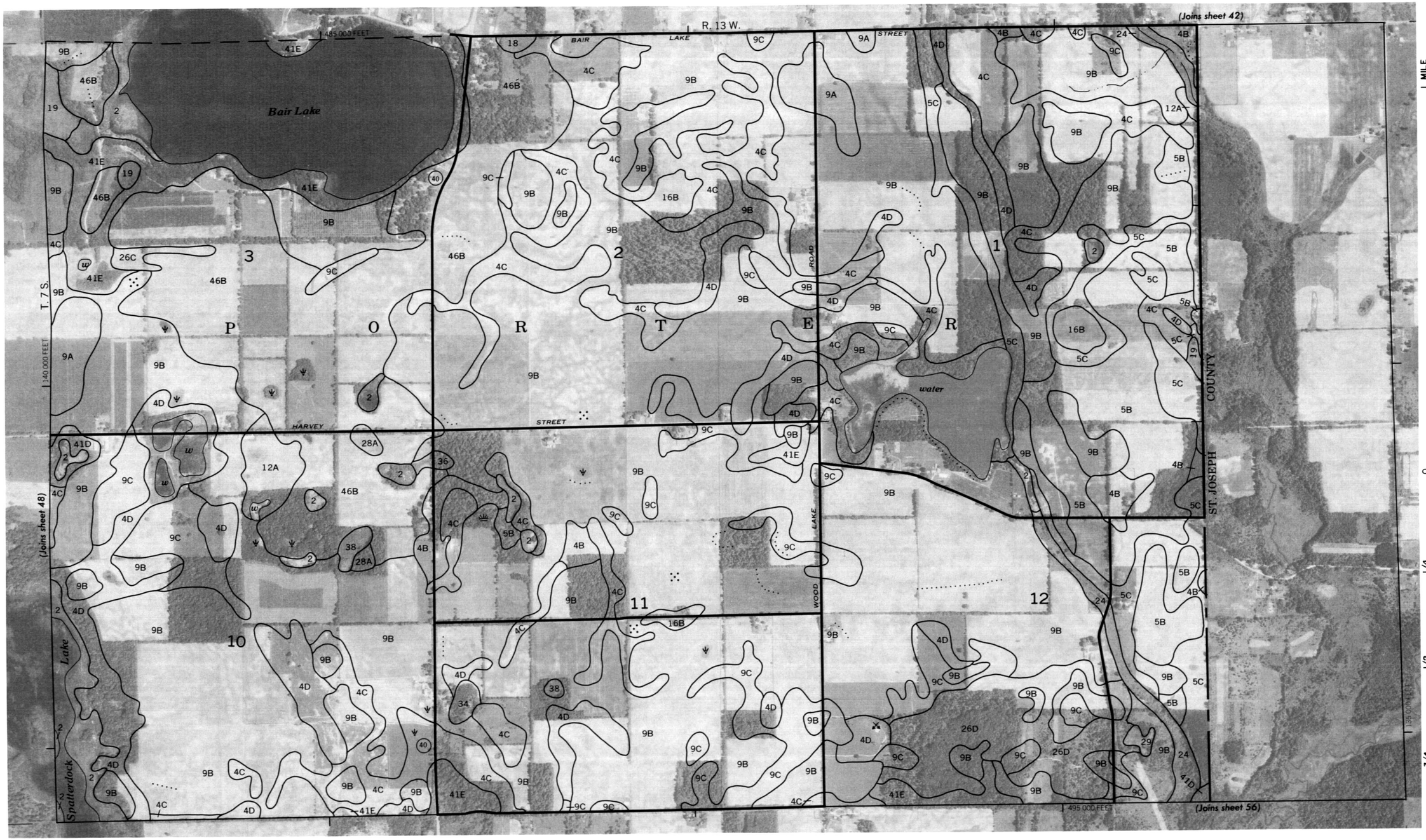
12 7 8 9

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY, MICHIGAN NO. 48

CASS COUNTY, MICHIGAN NO. 49

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



SOIL MAP OF CASS COUNTY, MICHIGAN — SHEET NUMBER 50

(50)

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4 1

(Joins sheet 43)

(Joins sheet 57)

(Joins sheet 51)

R. 16 W.

T. 7 S.

385 000 FEET

375 000 FEET

30 000 FEET

20 000 FEET

CONSOLIDATED RAIL CORPORATION

BERRIEN COUNTY

TERMINAL STREET

ZILKE STREET

HOYT STREET

LAKE STREET

BARRON LAKE ROAD

HOWARD

Barron Lake

McKinzie Creek

water

18 17 16 15 19 20 21 22

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY, MICHIGAN NO. 50

CASS COUNTY, MICHIGAN NO. 51

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

390 000 FEET

R. 16 W. | R. 15 W.

(Joins sheet 44)

T. 7 S.

130 000 FEET

HOYT STREET

COULTER STREET

ANDERSON ROAD

CONRAD ROAD

DAILEY ROAD

McKinzie Creek

water

HOWARD

(Joins sheet 50)

(Joins sheet 52)

(Joins sheet 58)

405 000 FEET

125 000 FEET

Scale 1:15 840

MILE

KILOMETER

0 0

1/4 0.5

1/2

3/4

52

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 0.5 1

1/4 1/2 3/4 1

R. 15 W.

T. 7 S.

(Joins sheet 45)

(Joins sheet 51)

(Joins sheet 53)

(Joins sheet 59)

425 000 FEET

430 000 FEET

410 000 FEET

125 000 FEET

ROAD

DAILEY

JEFFERSON

CENTER

STREET

WESTERN

TRUNK

GRAND

Goose Lake

Gray Lake

Slab Lake

Crooked Lake

George Lake

water

17 16 15 14 20 21 22 23

J E F F E R S O N

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 52

N

CASS COUNTY, MICHIGAN NO. 53

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

R. 15 W. | R. 14 W.

T. 7 S.

430 000 FEET

(Joins sheet 46)

(Joins sheet 52)

(Joins sheet 54)

(Joins sheet 60)

Putterbaugh Lake

Robinson Lake

Leninger Lake

JEFFERSON

CALVIN

ROAD

CHURCH

BRICK

MT. ZION

CASSOPOLIS

STREET

440 000 FEET

1 MILE

1 KILOMETER

Scale 1:15 840

54

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4

R. 14 W.

460 000 FEET

T. 7 S.

10 000 FEET

125 600 FEET

445 000 FEET

(Joins sheet 47)

(Joins sheet 53)

(Joins sheet 61)

(Joins sheet 50)

Curtis Lake

Day Lake

Tharps Lake

Chain Lake

Long Lake

Round Lake

Calvin Center

CHAIN LAKE ROAD

CENTER STREET

CALVIN STREET

MT. ZION STREET

16 15 14 13

21 22 23 24

C A L V I N

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY, MICHIGAN NO. 54

55

CASS COUNTY, MICHIGAN NO. 55

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

R. 14 W. | R. 13 W.

465 000 FEET

T. 7 S.

1 300 000 FEET

(Joins sheet 48)

(Joins sheet 54)

(Joins sheet 56)

(Joins sheet 62)

460 000 FEET

1 925 000 FEET

Stage Lake

Shavehead Lake

SHAVEHEAD LAKE STREET

ROAD

UNION

BIRCH

N

1 MILE

1 KILOMETER

Scale 1:15 840

56

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4 1

(Joins sheet 49)

(Joins sheet 55)

(Joins sheet 63)

R. 13 W.

T. 7 S.

495 000 FEET

485 000 FEET

125 000 FEET

Spatterdock Lake

Wood Lake

Little Wood Lake

SHAVEHEAD LAKE

STREET

15 14 13 22 23 24

P O R T E R

ST. JOSEPH COUNTY

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY, MICHIGAN NO. 56

CASS COUNTY, MICHIGAN NO. 57

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

(Joins sheet 51)

(Joins sheet 64)

(Joins sheet 58)

375 000 FEET

385 000 FEET

120 000 FEET

115 000 FEET

R. 16 W.

T. 7 S.

BERRIEN COUNTY

HOWARD

Barron Lake

Jerry Tyler Memorial Airport

LAKE STREET

YANKEE STREET

Brandywine Creek

30 29 28 27 31 32 33 34

N

1 MILE

1 KILOMETER

Scale 1:15 840

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4 1

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY, MICHIGAN NO. 58

N

CASS COUNTY, MICHIGAN NO. 59

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

410 000 FEET

R. 15 W.

(Joins sheet 52)

(Joins sheet 58)

(Joins sheet 60)

(Joins sheet 66)

425 000 FEET

415 000 FEET

420 000 FEET

T. 7 S.

WESTERN ROAD

TRUNK

HESS ROAD

GRAND

DAVIS

LAKE

STREET

YANKEE

DAILEY

29 28 27 26 32 33 34 35

J E F F E R S O N

62

MILE

KILOMETER

Scale 1:15 840

60

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY, MICHIGAN NO. 60

N

R. 14 W.

445 000 FEET

120 000 FEET

T. 7 S.

(Joins sheet 54)

(Joins sheet 60)

(Joins sheet 62)

(Joins sheet 68)

460 000 FEET

115 000 FEET

ROAD

CALVIN

HILL

STREET

CENTER

LAKE

THARP

KESSINGTON

CASS COUNTY, MICHIGAN NO. 61

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 MILE

1 KILOMETER

0 0

1/4 0.5

1/2 1

3/4

Scale 1:15 840

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4 1

R. 14 W. | R. 13 W.

(Joins sheet 55)

480 000 FEET

120 000 FEET

115 000 FEET

(Joins sheet 61)

(Joins sheet 63)

(Joins sheet 69)

465 000 FEET

T. 7 S.

Teasdale Lake

Carters Lake

Robbins Lake

Mud Creek

TEASDALE LAKE ROAD

BIRCH ROAD

UNION ROAD

BALDWIN ROAD

PRAIRIE ROAD

25 30 29 28 31 32 36 33

P O R T E R

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 62

63

N

CASS COUNTY, MICHIGAN NO. 63

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

Scale 1:15 840

1 MILE

1 KILOMETER

0 1/4 0.5 1/2 1 3/4

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4 1

(Joins sheet 57)

R. 16 W.

385 000 FEET

410 000 FEET

T. 8 S.

(Joins sheet 65)

(Joins sheet 71)

375 000 FEET

405 000 FEET

BERRIEN COUNTY

Brandywine Creek

WORRELL STREET

BELL ROAD

IRONWOOD DRIVE

GUNWOOD ROAD

LEET ROAD

water

6 5 4 3 7 8 9 10

M I L T O N

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 64

65

N

CASS COUNTY, MICHIGAN NO. 65

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

R. 16 W. R. 15 W.

(Joins sheet 58)

390 000 FEET

110 000 FEET

T. 8 S.

RUNKEL ROAD

STREET

ANDERSON ROAD

CONRAD ROAD

MAY STREET

GRAND TRUNK WESTERN

Pleasant Lake

(Joins sheet 64)

(Joins sheet 66)

(Joins sheet 72)

405 000 FEET

105 000 FEET

T 7 S

1 MILE

1 KILOMETER

Scale 1:15 840

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4 1

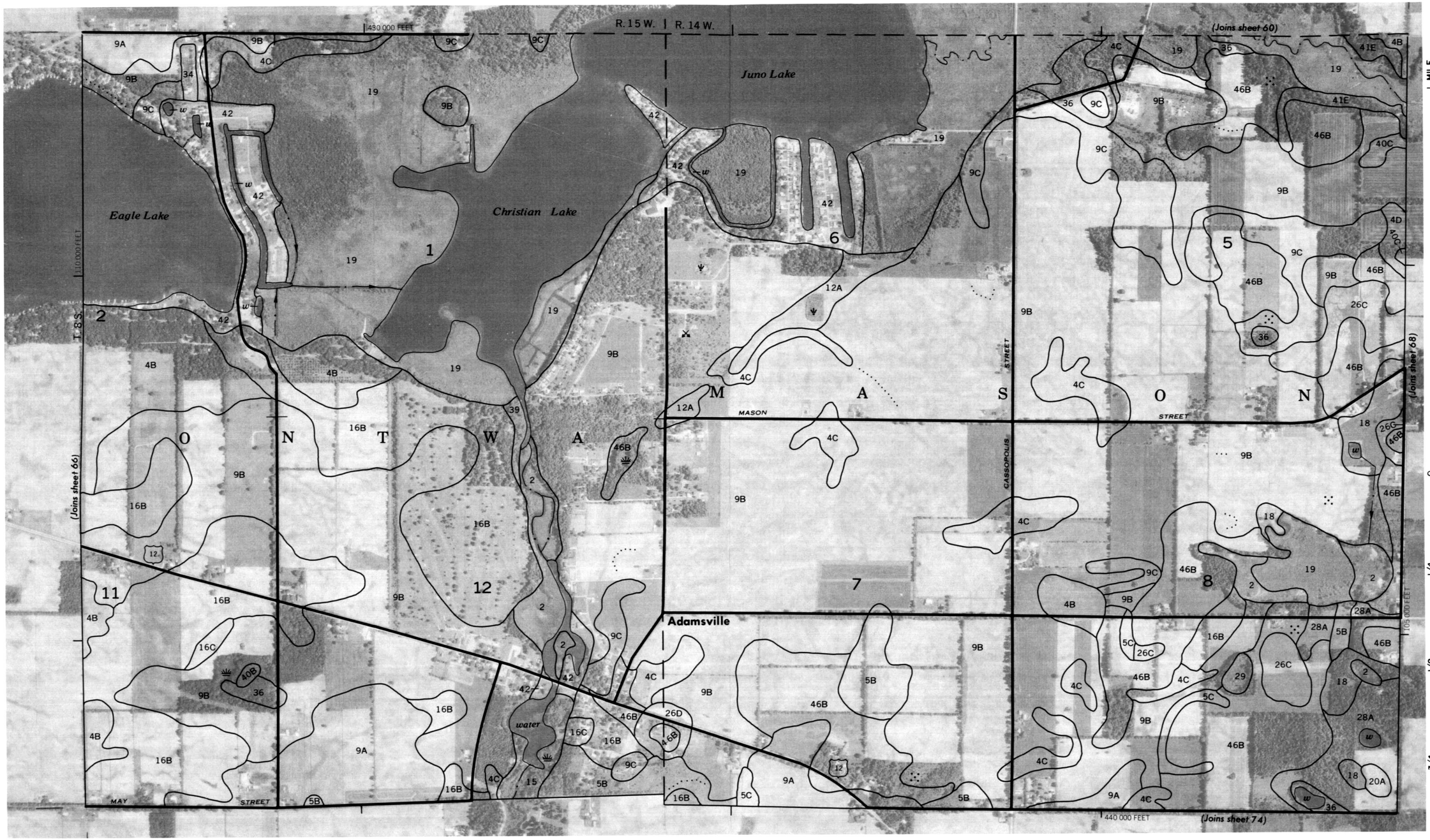
This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 66

N

CASS COUNTY, MICHIGAN NO. 67

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



1 MILE
1 KILOMETER

Scale 1:15 840

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 3/4 1

(Joins sheet 61) (Joins sheet 67) (Joins sheet 69) (Joins sheet 75)

460 000 FEET 445 000 FEET 105 000 FEET 110 000 FEET

R. 14 W. T. 8 S.

Lafferty Lake Mudd Lake

MASON CALVIN CENTER THARP KESSINGTON LAKE STREET ROAD

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY, MICHIGAN NO. 68

CASS COUNTY, MICHIGAN NO. 69
This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

R. 14 W. | R. 13 W.
465 000 FEET
T 8 S.
110 000 FEET
105 000 FEET
480 000 FEET
(Joins sheet 62)
(Joins sheet 68)
(Joins sheet 70)
(Joins sheet 76)
STREET
ROAD
UNION
PRAIRIE
BALDWIN
MASON
Union
Bellows Lake
Mud Creek
Long Lake
Baldwins Lake
water
1 MILE
1 KILOMETER
Scale 1:15 840

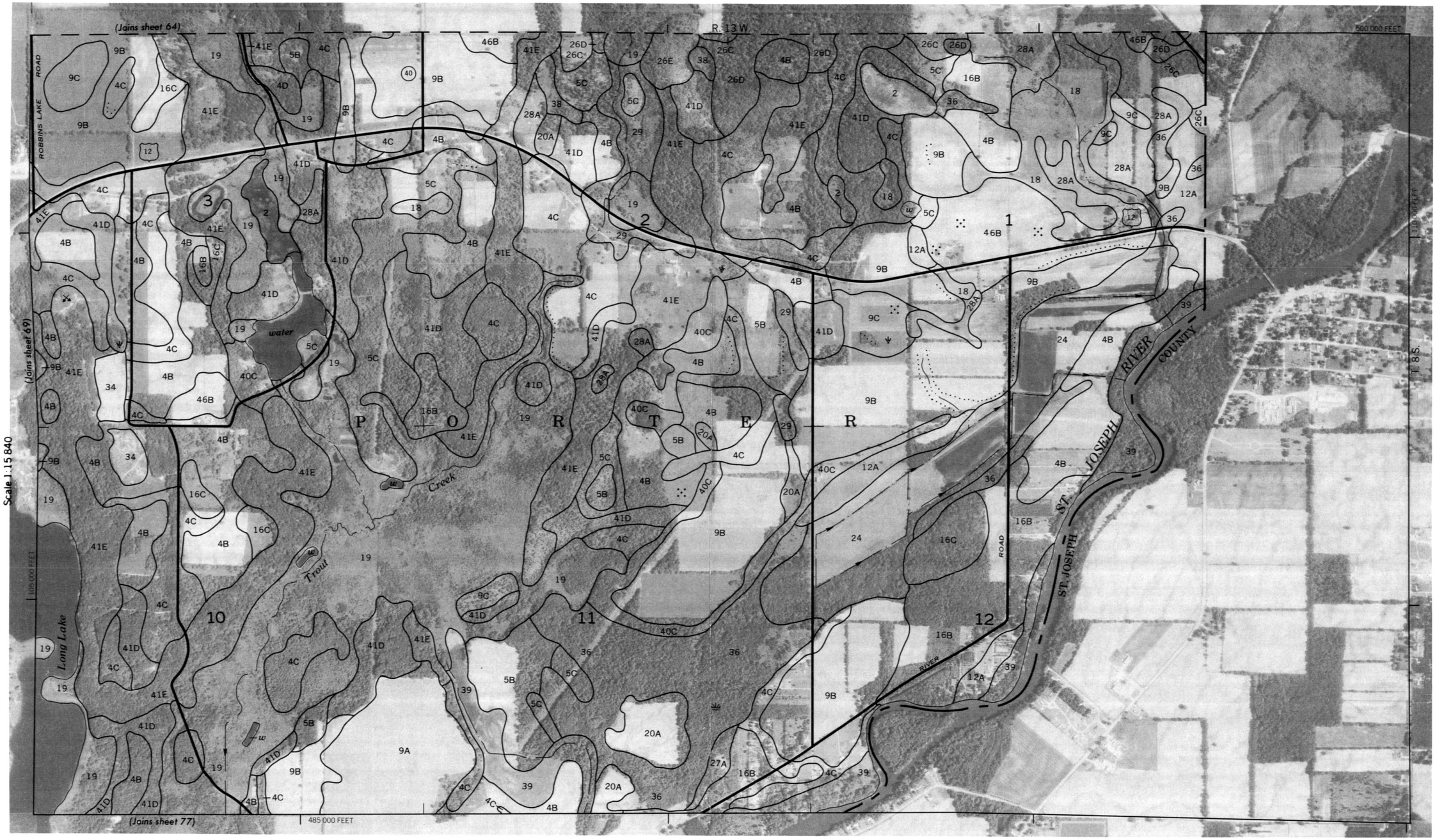
70

N

1 MILE

1 KILOMETER

Scale 1:15 840



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 70

71

N

CASS COUNTY, MICHIGAN NO. 71

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

375 000 FEET

R. 16 W.

(Joins sheet 64)

(Joins sheet 72)

T. 8 S.

COUNTY

BERRIEN

ST. JOSEPH COUNTY, INDIANA

385 000 FEET

950 000 FEET

IRONWOOD DRIVE

GUMWOOD ROAD

REDFIELD STREET

MILE

KILOMETER

Scale 1:15 840

72

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4 1

(Joins sheet 65)

(Joins sheet 71)

(Joins sheet 73)

R. 16 W. | R. 15 W.

T. 8 S.

405 000 FEET

100 000 FEET

95 000 FEET

390 000 FEET

MILTON TOWNSHIP

ONTWA

15 14 13 18 22 23 24 19

REDFIELD STREET

CONRAD ROAD

GRAND TRUNK WESTERN

ST. JOSEPH COUNTY, INDIANA

5C 26C 46B 46B 41B 12A 41B 12A 36 5B 26C 2 4D 5B 20A 2 4C 4B 4C 4C 4C 4A 4C 4C 9A 4B 4A 9B 9C 4A 9A 4A 9A 4B 4A 9A 4A 3A 5B 3A 3A 4A 22 3A 4A 9B 3B 3A 4C 4C 9B 3A 9B 9A 9B 9A 9B 4C 4A 5B 4B 4C 23 4C 9B 4B 4C 4C 4B 4C 36 4B 4C 9B 30B 9A w 41D 4B 4C 9B 4B 4C 4B 5C 4A 24 3A 3A 4B 30A 30B 4B 30A 4C 4B 36 4C 36 30A 30B 30A 30B 4B 30A 3A 30B 4B 4B 3A 41C 9B 27A 4A 45B 34 62 34 30B 30B 30A 30B 4B 30A 12A 62 4A 5B 4A 5B 19

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 72

CASS COUNTY, MICHIGAN NO. 73

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

N

R. 15 W.

Garver Lake

MAY STREET

REDFIELD STREET

ELKHART ROAD

37B

(Joins sheet 66)

(Joins sheet 74)

(Joins sheet 72)

410 000 FEET

425 000 FEET

100 000 FEET

95 000 FEET

T. 8 S.

17

16

15

14

20

21

22

23

O N T W A

ST. JOSEPH COUNTY, INDIANA

ELKHART COUNTY, INDIANA

1 MILE

1 KILOMETER

Scale 1:15 840

74

N

1 MILE

1 KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 3/4 1

(Joins sheet 61)

(Joins sheet 73)

(Joins sheet 75)

R. 15 W. | R. 14 W.

440 000 FEET

430 000 FEET

95 000 FEET

100 000 FEET

T. 8 S.

REDFIELD STREET

ADAMSVILLE ROAD

CASSOPOLIS ROAD

Christiana Creek

ELKHART COUNTY, INDIANA

T O W N S H I P

13 14 15 16 17 18 19 20 23 24

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CASS COUNTY, MICHIGAN NO. 74

N

CASS COUNTY, MICHIGAN NO. 75

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown are approximately positioned

445 000 FEET

100 000 FEET

R. 14 W.

(Joins sheet 68)

(Joins sheet 74)

(Joins sheet 76)

T. 8 S.

Kessington

CASSOPOLIS

LAKE ROAD

THARP ROAD

ELKHART COUNTY, INDIANA

460 000 FEET

95 000 FEET

1 MILE

1 KILOMETER

Scale 1:15 840

76

N

MILE

KILOMETER

Scale 1:15 840

0 0 1/4 0.5 1/2 1 3/4 1

R. 14 W. | R. 13 W.

(Joins sheet 69)

(Joins sheet 75)

(Joins sheet 77)

480 000 FEET

100 000 FEET

95 000 FEET

465 000 FEET

T. 8 S.

T 38 N

R 4 E

R 3 E

PRAIRIE ROAD

WAYNE STREET

BALDWIN

Baldwins Lake

Long Lake

Indiana Lake

Cloverdale Lake

ELKHART COUNTY, INDIANA

13 18 17 16 24 19 20 21

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

CASS COUNTY, MICHIGAN NO. 76

77

N

CASS COUNTY, MICHIGAN NO. 77

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

485 000 FEET

100 000 FEET

R. 13 W.

(Joins sheet 70)

(Joins sheet 76)

T. 8 S.

P O R T E R

15

14

22

23

Long Lake

Trout Creek

IDLEWILD ROAD

BELLOWS ROAD

RIVER ROAD

ST. JOSEPH RIVER

ST. JOSEPH COUNTY

water

ELKHART COUNTY, INDIANA

500 000 FEET

95 000 FEET

1 MILE

1 KILOMETER

Scale 1:15 840